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## SUPPLIERS OF ELECTRICITY.

A CONSIDERATION of the various conditions under which suppliers of electricity will labour, may not at the present moment be out of place. In these days of provisional orders, electricity must be supplied either by private enterprise or public bodies. A well established company undertaking the lighting of a given district will certainly offer advantages which can be gained by no other means. Possessing, as it would, a thorough knowledge of the many details in connection with the installation and maintenance of central stations, and retaining a staff of competent engineers and workmen, it cannot fail to do otherwise. A commercial company is formed with the avowed purpose of making money, and it is, generally, under the management of able financiers who value the principles of true economy. Another important fact in electrical work is that the erection of installations is the best proof of their capabilities, they strive after attaining the greatest possible amount of success in their undertaking, as they recognise that one piece of well executed work will bring increased prosperity.

Companies cannot now afford, even had they the inclination for, experimental work, they start out with a settled plan and do not deviate, except, perhaps, in the matter of detail. Another advantage, not possessed by local bodies is in the letting out of the smaller portions of the work. In their business relations they meet with the best of firms in whom reliance can be placed. Local prejudices have but small weight, they steer clear of the claims of the contractor who, alas, so often is the bone of discontent, and the cause of the petty struggles of local factions. In their own interests the work is pushed on, valuable time cannot be frittered away, people are waiting for the current. The companies push on with great expedition, and the work should be done to the satisfaction of all concerned.

The Board of Trade has done and is prepared to do a great deal for the local authority which is anxious to have the powers of lighting in its own hands. Many local boards and vestries are bestirring themselves, and the result is that powers have been awarded and gigantic schemes are being embarked upon.

Here we enter upon the domain of a great and vexed question. There are so many side issues, great and ever varying conditions to be noted, that it requires grave thought to arrive at some fair and reasonable decision respecting the lighting of a district by the elected representatives of the ratepayers. Truly it is a hard task for the local authority to settle judiciously between the rival claims of companies and the scheme brought forward in its own behalf. From a ratepayer's point of view it is only natural to suppose that electricity can be supplied cheaper by a body which desires no profit than by a private concern living by the sale of current. If all things were equal this undoubtedly is the correct way of looking at the matter, but the conditions are so different that there seems little comparison to be drawn. In the selection of a consulting engineer, upon which the success of the local scheme depends, a caution must be exercised which cannot be expected from non-electricians, they cannot arrive at any sound judgment upon the plans submitted by an expert whose self-interest may be wrapped up in the system advised. Electric lighting committees may be appointed, weekly meetings may be held, but the fact remains that they are simply and quietly guided by the technical adviser. We have an instance before us in which, in our opinion, a vestry has committed an error of judgment in the choice of a consulting engineer. The course of time, however, may prove our surmise wrong; we sincerely hope it may.

Where a corporation owns the gas works it certainly has a great advantage, as there is a well trained staff, whose energies may with rapidity be directed to the production of electrical energy, but in the present stage of electrical education, we emphatically state that the lighting of a district by any local authority is extremely risky. The work cannot fail to be ex-

perimental, in opposition to which we have a company of recognised ability ready and willing to make the most favourable terms if allowed to do the work.

We cannot close this article without commenting upon the action of many local authorities which have decided to oppose companies without any substantial reason; in fact, they seem to imagine if an electric company were allowed to light the district it would mean ruin to the community. Such is not the case, and we would earnestly recommend that bodies should consider carefully the matter, and, if no reason for opposition be found, that they help on the work of electric lighting by granting permission to a responsible company to apply for a provisional order. If this step be adopted, they will not regret it, and by working amicably hand in hand with the selected company, many difficulties will be avoided which will otherwise confront them.

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**Battery Resistance.**

IT has often been suspected that, irrespective of the variations caused by temperature, alteration of the density, and concentration of the solutions, and polarisation, the resistance of primary batteries and of accumulators is not a constant quantity. It is only recently, however, that determined attempts have been made to prove this suspicion an undoubted fact. MM. P. Bary and G. Margaine, who have taken the subject up, have obtained some most interesting results which have lately been completely confirmed by experiments, the results of which are given in a recent number of *L'Electricien*. These results obtained on Leclanché batteries prove that "the internal resistance diminishes as the current flowing increases." Why this change in resistance takes place has not yet been determined; polarisation may have *something* to do with it, but from the way in which the experiments were made it does not appear that it is the actual cause. The whole question is decidedly an interesting, if not an important, one, and we hope it will be thoroughly threshed out by able hands.

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**Henniker Heaton and the Cable Ring.**

IF Mr. Henniker Heaton ever reads that weekly journal which offers exceptional advantages to advertisers and claims the largest circulation of any English electrical paper, he must now be broken down with remorse and regret that he had the temerity to comment, even with bated breath, upon the policy of the cable clique and its formidable leader. So fearful is our contemporary of the dire effects to which Mr. Heaton's malignant insinuations may give rise, that the Society of Arts is solemnly warned against letting its journal become the medium for disseminating his gratuitous slanders, and one could almost imagine that the editing is done in Old Broad Street and not in Salisbury Court at all. We did not expect to find a verbatim report of Mr. Henniker Heaton's lecture in our contemporary's already overloaded columns, but we did not anticipate that his pungent remarks would have been so seriously taken to heart.

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**High Tension.**

THE *Electrician* in discussing high and low tension says: "The question of danger which has been raised in connection with high tension systems may refer either to the danger of fire or to the danger to human life. . . . . The real point is, whether the accidents which have happened are sufficiently numerous to justify the public in regarding them as dangerous. Our opinion is distinctly the reverse. Practically all these accidents have occurred in America, where installations are managed in a much less careful way than in this country." We would like to ask where else our contemporary expected these accidents could have happened? Is not the bulk of electric lighting by high tension currents done in the States, and have we not been rather too hard upon American practice generally? Let us wait until we approach somewhat to the situation in New York, and then, if we are lucky enough to steer clear of fatalities, we may congratulate ourselves that we are not as other men, meaning thereby our Transatlantic cousins. To quote railway accidents, street casualties, petroleum lamp fatalities, gas explosions, &c., is quite beside the question. We know we are running a risk, small as it may be, when travelling by rail; we are in danger of being knocked down when crossing a street; a lamp may be upset quite against our will, and gas may send us flying without preparation; all these things are dangerous, so are high tension electric currents, and we must try to keep ourselves safe by the exercise of due precautions and common sense. While, however, the dangers which have hitherto beset our daily existence are known and provided against by ourselves or others in so far as human skill can do so, there is much to be learned yet concerning the effects of electric shocks.

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**Virtuous Indignation.**

A CONTEMPORARY is scandalised that the *Standard* and *Daily News* should publish telegrams from America relating to fatal accidents from electric light conductors without a word of qualification or explanation. As the gist of these communications is almost invariably to the effect that another victim has been added to the long list of fatalities, we fail to see what exception can be taken to a statement of fact. "A careless student drops an oil lamp and a university is burnt down; at a drunken carousal a lamp is knocked over and a block of buildings destroyed and several lives lost." Why, asks the writer, have we not had sensational paragraphs about the use of oil? We should say that we have had them and concerning gas also, *ad nauseam*, but that was before the *Electrical Engineer* was dreamt of. Paragraphs like these have had their day, and now it is the turn of electricity to occupy the position that its rivals had to bear and ultimately emerge from years ago. If our contemporary would only protest as vehemently against the insertion of the columns of Electropathic quackery advertisements in these papers as it does against bad workmanship, it might be doing its little towards enlightening the public on a matter as important to health and life as is the electric light itself.

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**Transformers.**

SPEAKING of transformers, the *Electrical Engineer* remarks:—"It has been said that perchance the pressure of two thousand will get into the house mains by contact somehow of the primary and secondary of the transformer. There is no difficulty here. If, with the existing transformer, such a thing is possible, it is easy to make a transformer where it is impossible." Now we know that it is not only possible, but that such an incident recently occurred with serious consequences; we also admit that these vagaries of the high tension current may be made impossible, though, as we have recently pointed out, it will be at the loss of efficiency in the yield of the apparatus.

Reliable Information.

MR. STEAD'S new venture, the *Review of Reviews*, is a wonderful thing of its kind. The number for this month commences with an article called "The Progress of the World," from which we extract the following :—"The substitution of electricity for horse traction, which is now in progress, will, by cheapening the cost, tend to facilitate this change. (Here is meant the supposed buying up of railways, omnibuses and tramcars by the State.) The 60 miles of roadway covered by the tramway and omnibus companies in Liverpool will soon be served by electric cars ; and in London the experiment has been tried with such complete success that the disappearance of the horse is only a matter of time. Six storage batteries, which can be replaced, when exhausted, in three minutes, will draw a car carrying 52 persons for 35 miles at a possible speed of 20 miles an hour. The cost per mile is not more than 5d. per mile, as 6½d. per mile now paid for horse traction. The electric car is under perfect control and does the work of 60 horses." Truly this shows not only a remarkable development in electric traction, but also on the part of Mr. Stead's contributors.

A Death from Electricity.

THERE is an air of inexpressible sadness in the plain, bald notice in the *Times* of the death of Mr. Harvey W. G. Philpot, of Quebec, who was killed on the 21st February by an electric shock. The deceased is, we understand, the son of Dr. Harvey Philpot, of London, and went out to Quebec some time ago to fill a position in the Electric Light Works there. While turning on the current in the office of the company, he came into contact with another connecting wire and fell dead. In the language of the obituary notice in the journal mentioned, he was killed in the discharge of his duty.

Negligent Lighting.

A COPY of the following letter has been sent by Mr. A. A. C. Swinton to the secretary of the railway department of the Board of Trade, which shows an extraordinary loose state of affairs :—

Sir,—In ——— Street, ———, there is in the shop of an ironmonger of the name of ———, an electric light transformer fixed on the wall, in close proximity to the public entrance of the shop. This transformer, which, I understand, was fixed, and is supplied with a 2,000 volt alternating current by the ———, has no cover of any description, and the terminals and connections are exposed in such a manner that any person or child entering the shop and accidentally, or purposely, touching these latter, might easily obtain a fatal shock. I am informed that the apparatus has been in this condition ever since it was fixed, about a fortnight ago, although the danger has been repeatedly pointed out to those responsible. Surely such a state of matters should not be allowed to continue.—I am, &c., A. A. C. SWINTON.

The thanks of the public are due to the timely action of Mr. Swinton ; and, before too late, the authorities should interfere and have the matter remedied. Such culpable negligence on the part of the supplier and the consumer must meet with the strongest condemnation of professional men. We might point out that should any accident occur, more than one person would have severe indictments brought against them.

Electric Car Conduits.

THE conduit for electric street cars which we describe on another page appears to be similar to one described in the REVIEW some time ago, in which we believe Mr. Binswanger was interested. Certainly the American inventor has been forestalled by more than one person in this country if we recollect aright. Mr. Wynne's scheme, which has been presented to us since, seems also to follow a similar path. This system of Mr. Wynne can hardly be said to be quite novel, similar underground and sectional conductors for electric tramways having been suggested by the late Prof. Fleeming Jenkin and by Profs. Ayrton and Perry. The method of "picking-up" the current underground without a slotted conduit, and by means of electro-magnets, has been suggested by Messrs. Pollack, Binswanger, and others. There are numerous objections to such a system ; how many of these have been removed will be demonstrated only in practice ; for we assume that at present the so-called Wynne system is merely on paper, or, probably, has not been tried further than with a small model. It does not seem opportune now to consider at length Mr. Wynne's system, for anyone acquainted with the contents of the ELECTRICAL REVIEW will at once observe the similarity between the present design and those which have been described by us during a period covered by, say, the last eight years.

Dynamo Designing.

WE completed in our last issue the paper of Mr. Jas. Swinburne, read before the Institution of Electrical Engineers, and give in the present number the first portion of the paper by Mr. W. B. Esson, read at the succeeding meeting. These papers deal with a subject upon which, so far as we know, nothing has yet been written, and serve to show that the men who make dynamos have points to consider which are not discussed in texts books or referred to in professorial lectures. We do not recollect any rules having been published before, specifying the ampère-turns which can be carried by armatures, though the question is, as one of the authors says, of the utmost importance. Nor do we remember having seen any practical determination of the ampère-turns on the magnets required to compensate the weakening effect of the armature. These points are fully considered in the two papers upon which the discussion was opened last night, and we have no doubt that they will be fruitful of a most interesting interchange of views.

Motor Reactions.

BOTH the engineers mentioned have fallen foul of the Ayrton and Perry theory of motor reactions, and though they both give reasons for their beliefs, it cannot be expected that they will be altogether successful in convincing the opposite party, or, as Mr. Esson facetiously puts it, the "large armature school." These gentlemen have evidently some intention of "drawing the badger," and we are just waiting to hear how the badger takes it, and to ascertain whether there is a prospect of this often-discussed motor question ever receiving a final settlement.

Accumulator Charging from Alternators.

THE mode of distribution proposed by Mr. R. F. Yorke in another part of our columns does not appear to us to possess any advantage over a direct current system having the same mean difference of potentials. Mr. Yorke seems to think that for distribution over large areas the alternating current is successful *because* it is alternating, whereas it is the pressure and not the nature of the current which determines the distance of transmission. With a direct current system, direct current transformers, and secondary batteries, all that our correspondent claims for the proposed scheme can be obtained with much less trouble and expense ; in fact, the system we refer to is already adopted, and may be seen at work any day in Chelsea.

## THE INTRODUCTION OF THE ELECTRIC LIGHT IN FRANKFORT-ON-THE-MAIN.

[FROM A CORRESPONDENT.]

THE municipal authorities of Frankfort have appointed a commission of experts to examine the plant and machinery proposed for the purpose of introducing the electric light, to consider the possible dangers, the value and the general applicability of the competing systems; and, finally, to pronounce on the question of which system is the best adapted to the existing conditions. The Commissioners gave in their report on November 10th, 1889.

The first question relates to the comparative danger of alternating and of continuous currents for workmen and consumers.

In both systems, as proposed, the machines and apparatus at the central station and the high tension primary conductors are accessible only to the trained *employés* of the projectors. With proper construction and management of the machines and apparatus every danger to workmen can be avoided both on the continuous and the alternating system. In case of incautious treatment of the machines and primary conductors there is practically no difference between the effect of a continuous current of 2,000 volts tension and of an alternating current of the same tension; the one or the other might prove fatal.

In the proposed installation of primary current transformers the total separation of the primary and secondary coils of the transformer obviates every possibility of the passage of the high tension primary current into the secondary coils, and, consequently, to the parts where the consumption takes place.

In the transformers worked by an alternating current by means of proper insulation and of a sufficient distance between the secondary coils and the other parts of the transformer, the dangers for the consumer may be reduced to such an insignificant degree that they do not require practical consideration. For, in installations of this kind, but with less perfect appliances than those proposed for Frankfort, no single case has come to our knowledge where a transit of the high tension primary current into the secondary leads and apparatus has occasioned death or even severe injury. According to the system proposed for Frankfort the current entering the houses will have only a tension of 100 volts.

The dangers which might arise from the proposed "five-lead" system of Messrs. Siemens and Halske, with its tension of 440 to 500 volts, can be reduced to such a trifle by suitable and careful management, that they do not form any argument against the adoption of this system.

2. Concerning alternating current motors the following questions are proposed:—

*a.* How high is the performance and the degree of efficiency of the new alternating motors of the firm Ganz & Co.? In how far is the efficiency of this motor affected by the size of the motor, and by its varying load?

*b.* Does this motor start automatically? If not, what means are necessary to set it in motion? How long does it take to reach its normal number of rotations?

*c.* What phenomena attend the starting and the normal work of the motor?

*d.* What is the number of rotations with different loads?

*e.* What phenomena occur on suddenly unloading or loading the motor within wide limits?

*f.* How does the motor act when it is more and more loaded beyond its normal limits, and is an irregularity or a stoppage of the motor to be expected if the size of the motor is suitable?

*g.* Can the new alternating current motor be applied in the small industries and for domestic purposes, and for driving tramcars, and if so, by what means?

*h.* What are the properties of the continuous current motor as regards the points *a* to *g*?

In the experimental measurements of the Commission a 25 and a 5 H.P. alternating current motor of Messrs. Ganz & Co. were examined as to their degree of performance. The results were very favourable. The efficiency of the 25 H.P. motor, if working up to 15—35 effective H.P., gave returns of 82 to 88 per cent., and if loaded up to 35 H.P. it still gave 85 per cent. of useful work. The small motor, with a normal load, gave 78 per cent. of efficiency, and for work of from 3 to 8 H.P. the efficiency fluctuated between 60 and 80 per cent. Hence the efficiency of the motors of Ganz and Co. falls short by a mere trifle of the efficiency at present attained by continuous current motors. In adjudicating on the competing projects this difference has no practical meaning.

The alternating current motor examined requires for starting, in addition to its introduction into the circuit, a second manipulation. The continuous current motor requires merely introduction, a displacement of the brushes being rarely needful. Of the three alternating motors examined the 25 H.P. never starts automatically; the 5 and the ½ H.P. start automatically only from certain initial positions. The manipulations needed are so simple in comparison with those required for steam and gas motors that the Commission does not consider this point a disadvantage of the alternating as compared with the continuous motors.

No attempt was made to start the alternating machines when loaded, since, according to the instructions of the makers, this is generally impossible.

The continuous current motor starts in any position without help, even when loaded beyond its normal power. In this respect the continuous current motors have a considerable advantage over the alternating motors—those, at least, of the types examined.

The time required before an alternating current machine, with the driving band on, reached its normal speed was from 30 to 40, sometimes 45 seconds.

The starting of the two larger alternating current motors was attended with a brisk production of sparks at the brushes and commutator, lasting until the speed became normal (synchronous). With the 25 H.P. motor the sparks were about 5 cm. in length, and with the 5 H.P. 2 to 3 cm. When the normal speed was reached the length and intensity of the sparks was reduced to the slight signs which are seen at the commutators of continuous current machines with a small number of plates.

The smallest alternating current motor produced sparks in so trifling a degree that they do not need mention. This production of sparks must be considered both as regards the wear and tear of the commutator and brushes, and also as regards the danger of fire.

In the first respect the alteration is very insignificant. The metallic dust collected on starting the large motor is, on an average, each time 17 milligrammes.

To prevent the danger of fire a sheet iron plate should be laid under the commutator.

An alternating current machine works, of course, more noisily than a continuous current machine. This noise is unimportant for manufacturing establishments and for working tram lines, but it will exclude the use of large motors in inhabited houses. The noise of small alternating current motors for the purposes of domestic industry is not great.

The alternating current motor examined is synchronous, *i.e.*, it runs in complete accord with the primary machine at the central station.

The speed of continuous current motors depends on their load, but in good motors the fluctuations do not exceed 3—4 per cent., if the tension at the terminals is constant. Hence, in practice, there is no important difference between the two motors as regards self-regulation.

Whilst the continuous current motor allows of the regulation of its speed by the introduction of graduated resistances, such a regulation is not possible with the synchronous intermittent current motor.

But as in permanent work with diminished speed, in most cases, stepped driving discs are brought into use, no essential difference can exist in this case between

the two systems. Still, the above-named property of the continuous current motor will be of value in all cases where a transitory change of speed is desired.

For deciding the behaviour of the alternating current motors of Messrs. Ganz & Co., on overloading and on sudden unloading and loading, both the large and the small motor were submitted to a series of experiments.

It was first determined what maximum work the motors called by the firm 25 H.P. and 5 H.P. were capable of performing. Repeated trials showed that the larger motor, if its load was gradually increased, did not cease its synchronous movement and come to a stop until it reached an effective duty of more than 40 H.P., that is, about 60 per cent. above its normal performance. Corresponding experiments on the 5 H.P. motor showed that it could be worked up to 8 effective H.P., also 60 per cent. above its normal performance.

In the experiments to ascertain the behaviour of the Ganz alternating motors when suddenly loaded or unloaded, care was taken that the number of rotations of the machine producing the current should remain, as far as possible, constant in all the sudden changes of load undertaken at the motor. To this end the load was once thrown upon a tertiary dynamo, driven by the secondary machine, and at another time directly upon the primary machine; the latter worked therefore approximately regularly with an unchanged load.

The following results were obtained with the 25 H.P. motor:—

1. Whilst running free, or with a load below its normal standard, any increase of load up to 26 H.P. can be thrown suddenly upon the motor without affecting its synchronous movement. But if a load of more than 26 H.P. is suddenly thrown upon the motor, it loses its synchronism and comes to a stand.

2. If the motor is working with a normal load it can bear a sudden increase of 8 H.P. in addition to the 26 effective H.P. with which it was working, and then further sudden increases, making up 6 H.P., *i.e.*, together—40 effective H.P. Any sudden loading beyond this point throws the motor out of its course, and brings it to a stop.

A sudden unloading of the motor from its maximum performance (40 H.P.) down to 0 occasions no change in the course of the motor.

In the 5 H.P. motor it was found that it could bear an extra load of 0 to 6 H.P., and that even in the case of the sudden addition of 9 to 10 H.P. the motor was able to run on by means of the coupling.

Whilst the maximum performance of the alternating current motor is limited by the maintenance of synchronism, in the continuous current motor, both the amount of the permanent maximum load admissible and the amount of the admissible sudden or temporary overloading is fixed by the height of the temperature which the motor may reach without injuring its durability and destroying the insulation. Hence it follows that the maximum performance of a continuous current motor varies greatly, according as it is to be transient or more permanent. Thus the Schuckert 1½ H.P. continuous current motor, which has a normal current of about 15 ampères, can be got to work with a load which requires 150 ampères.

(*To be continued.*)

## ELECTRIC LIGHTING IN INDIA.

UNDOUBTEDLY the most beautiful exhibition of electric lighting ever seen in India was that witnessed at the illumination of the Taj, at Agra, on the evening of the 22nd January. The installation was in honour of H.R.H. Prince Albert Victor's visit to that city, and presented a most entrancing spectacle. Apart from the historical interest with which the Taj is vested, the building itself represents, perhaps, the finest existing specimen of barbaric art in India; some interest must also be felt at this blending together of the "old and the new." The Taj was erected during the reign of the Emperor "Shah Jahán," and is supposed to have been completed about the year 1640, A.D. It is a mausoleum for his favourite wife, called Mumtaz-i-Mahl, or "Exalted one of the Palace;" but he, himself, is also buried in the building, his own mausoleum not being completed at the time of his death. The Taj is built of pure white marble, and consists of a central dome, 296 feet in height from lower platform to the summit of the pinnacle. The upper platform is an exact square of 313 feet each way, and at each corner stands a column, or tower, 137 feet high, and crowned with a small pavilion. The whole of the domes and the interior of the Taj are beautifully inlaid with mosaic panels, scrolls of coloured stones, and mother-of-pearl. It would have been a work of extreme difficulty and danger to have placed a light on the pinnacle of the central building, so it was decided to illuminate it by reflected light thrown from the four minarets. These lights were so arranged that the dome appeared like an immense globe of soft white light, without any apparent source of supply, throwing out scintillating rays from the various mosaics.

His Royal Highness seemed to thoroughly appreciate the magnificence of the Taj, but lit by the electric light, it presented a most unprecedented spectacular triumph and a sight which baffles all description. The reflection of the outside lights could be seen down the line of railway for upwards of twenty miles. The interior of the mausoleum was also illuminated by 1,000 C.P. incandescent lamps, and greatly added to the effect of the installlation.

The whole scheme was devised and carried out by Mr. Lester Betts, the electrician in India of the Silvertown company. His Royal Highness expressed himself much pleased with the display.

## ELECTRICITY IN THE HOUSE OF COMMONS.

THERE has been quietly working for the past five years a small installation in the precincts of the famous courts of St. Stephen for the supplying of current to various parts of the House. Though unpretentious in appearance, its good working results might be favourably compared with many later erections.

A short time ago, as mentioned in a previous note, the electric lights in the House were added to by a further supply from the Westminster Electric Supply Corporation; the work done by this company, however, does not greatly affect the old installation.

In the basement under the great tower is situated a particularly clean and bright boiler house; this condition is arrived at by the use of coal bunkers, similar to those used on board ships. Here is placed a series of four Lancashire boilers, one of which is used for electric lighting purposes, the others for the heating of the House. Each boiler is equal to 120 I.H.P., is 7 feet in diameter and 28 feet long. Proceeding to the dynamo room one is rather suprised to find the original Edison machines, of the upright K and L type respectively, and it is a remarkable fact that since their laying down they have worked without a single hitch. The original brushes have been replaced by others of a more modern kind. Three dynamos are worked with link belting from Armington and Sims engines, one of which is kept in reserve. From this installation 630 lamps of 16 C.P. can be supplied, but when the new lamps were added a portion of these was taken in hand by the Westminster Company together with the new additions. The lighting of the principal rooms is divided, so that in the case of a breakdown on the part of the company or of the House installation it would cause little inconvenience.

There is not a general switchboard, but several small boards are placed in various parts of the House, each controlling a given area.

At present there is lighted St. Stephen's Hall, members' cloak room, Commons Lobby, new and old dining rooms, ministers, reporters and reading rooms, and the library.

From the respected interior of the Chamber the electric light has been ejected, it is said, for interfering unduly with the "talk" of the members. An experimental arc light was placed in the ceiling by the Brush Company, but it did not work well, and was often known to hiss during the progress of a speech. It was ousted from its temporary elevation, and gas continues to light the Chamber. It is probable it will do so for many a day, unless it is found convenient to adopt the incandescent lamp.

Great economy has been effected in placing the lamps in the old gas pendants; this is noticeable in St. Stephen's Hall; indeed, it would have been a thousand pities to have taken down such beautifully designed chandeliers as are suspended from the roofs.

The wiring and fittings inside the building have been carried out from the designs and under the supervision of Mr. Prim, the resident engineer.

## ON THE CONDITION OF THE MAGNETIC FIELD IN CONDUCTORS OF THREE DIMENSIONS.

THE result, writes M. P. Joubin in *Comptes Rendus*, of an electric current traversing a linear conductor is to transform the entire exterior circuit into a magnetic field; that is to say, a small quantity of magnetism or a particle of current, applied to any point, develops a tendency to movement under the influence of the E.M.F. The difference between the two regions of space separated by the conductor's surface seems then to be very distinct. In the one an *electromotive* force, acting exclusively upon the electricity, is driven in the direction of the current; in the other, an *electro-magnetic* force, applied to the support of the current or of the magnetic body, takes an entirely different direction; for instance, in the case of an indefinite rectilinear current, this will be a plane perpendicular to the wire. Will this always be the case when, instead of a linear conductor, we are dealing with a conductor of three dimensions? Is the magnetic field limited by its exterior surface?

My purpose is to investigate these two points by determining the action, over the entire space, of a current traversing a rectilinear conductor of an indefinitely large section.

The kind of conductor aimed at is obtained in the following manner:—A large glass sleeve of 18 cm. diameter and 60 cm. in height is placed over a layer of mercury contained in a three-legged iron pot filled with a solution of sulphate of copper; the mercury being forced outwards serves to balance the liquid column, while at the same time the lower stratum acts as an electrode for conducting the current. A second electrode is formed out of a sheet of copper of like diameter with the sleeve, and is maintained at the upper surface of the solution. The wires for conducting the current are fixed above and beneath, following the axis of the apparatus. Lastly, a miniature magnet and mirror are suspended in the interior of the cylinder by a cocoon fibre. The circuit having been closed we note the following:—

I. By placing a tube of very small diameter (5 cm., for instance) in the axis of the first-named sleeve, so as to insulate a portion of the space comprised in the interior of the current, we observe that the action of the annular portion of the current in every interior point of the tubes is *nil*.

II. We now remove the second tube and shift the magnet a distance equal to the length of the cylinder's radius: the action, from being at first *nil*, increases as fast as the magnet recedes and proportionally to the distance.

III. The same magnet, being suspended exteriorly to the sleeve, undergoes in the neighbourhood of its surface a similar action to that which it underwent on the other side in the interior of the sleeve; on withdrawing it, we observe the force varying in an inverse ratio to its distance from the cylinder's axis.

Such were the phenomena observed. It is easy to obtain a clear idea of them. In fact we may, in the conditions supposed, consider the current's density as constant in the cylindrical conductor, and divide this latter into differential parts, each traversed by the same current $i = \frac{1}{\pi R^2}$. Now, any one of these parts, B, has at a point, A, situated at a normal distance, $r = A B$, an action equal to $\frac{2i}{r}$ and perpendicular to the plane of the wire, B, and to the straight line, A B; so that what happens is as if the point of intersection, B, of the plane formed by A perpendicularly to the conducting wire acted upon the mass, A, equal to the unit according to the law $f = \frac{2i}{r}$. The same will be the case with the rest of the differential parts, which, combined, may be represented by the surface of the circular section of the cylinder, each of the points of which would act according to the foregoing law. It will then only remain to solve the integral $\int\int d\,S$, of which $d\,S$ represents a surface particle of this circle limited to its circumference. Let O be its centre.

Assuming the straight line, O A, to be the axis of $x$, the two components of the result at point A, X representing O $x$, Y representing O $y$, become

$$X = 2i \int\int \frac{r^2\, dr\, d\theta \sin\theta}{a^2 + r^2 - 2ar\cos\theta}$$

$$Y = 2i \int\int \frac{r\, dr\, d\theta\, (a - r\cos\theta)}{a^2 + r^2 - 2ar\cos\theta}$$

in which $a = A O$; $r$ is the distance of the element $d\,S$ from the centre, O, and $\theta$ the angle of $r$ with O $x$.

Supposing A to be exterior to the circle of radius R limiting the electric flow ($a > R$), it will be necessary to alter $r$ from 0 to R and $\theta$ from 0 to $2\pi$; then $X = 0$ and $Y = \frac{2i\pi R^2}{a}$, that is, the force will be the same as if the entire current ($I = \pi R^2 i$) passed into a rectilinear wire situated at the axis.

II. The action of a uniform circular ring, or one composed of uniform circular layers, is *nil* throughout the interior of the ring. This can be easily shown by a process of reasoning analogous to that employed by M. Bertrand in the case of a spherical electrified layer.

III. The inference is, that for a point situated in the interior of the circle of radius, R ($a < R$), the circular layer comprised within the radii, $a$ and R, possesses no action; therefore, by changing $r$ from $\theta$ to $a$ and $\theta$ from $o$ to $2\pi$ we get

$$X = o, \quad Y = 2i\pi a.$$

We may therefore infer that the magnetic field produced by a current exists in the circle which is traversed by the electric flow as well as in the exterior circle; that it possesses continuity in passing by the surface of separation; in fact, in proximity to this, in the interior, the force is $2i\pi(R - \epsilon)$, and at the exterior, $\frac{2i\pi R^2}{R + \epsilon}$; the difference between the values is extremely slight.

**Chinese Enterprise.**—Mr. Bert C. Lee, a Chinaman, is studying the Westinghouse alternating current system of electric lighting in Pittsburgh, U.S.A. Mr. Lee was sent to America at the expense of Chinese capitalists, and is qualifying himself to take charge of the central stations in China.

## THE FRENCH TELEPHONES.

AT a recent sitting of the French Chamber of Deputies, M. Henri Fouquier put a question to the Minister of Commerce and Industry on the eternal telephone question, in explaining which he said: I have laid on the table of the Chamber 850 petitions from members who complain of the working of the telephone in Paris, and the new conditions imposed on the subscribers by the Administration of Posts and Telegraphs. The subscription henceforth must be taken for three years instead of two; in case of death it remains at the charge of his family. The State reserved to itself the right of interrupting communications when it thought proper, or to requisition a subscriber's telephone in case of disorder or fire; those are the conditions which the subscribers criticise. They also complain of the manner in which the service is worked. The insufficiency of this service is recognised by the *employés* themselves. I wish to ask M. Tirard whether he cannot remedy these deficiencies; it is unjust, for the subscribers begin to be disheartened.

M. TIRARD, President of the Council, recognised the importance of the question put to him by M. Henri Fouquier. Complaints had been addressed to him on the defects of the service. There was, in reality, a trouble which was due to the epidemic which had reigned over Paris; absent *employés* had to be replaced by improvised *employés*. But for some weeks, now, that trouble had disappeared. The Administration was endeavouring to improve the service, but it only had in its possession the apparatus which had been left it by the old company. That apparatus was not up to the level of modern discoveries. At the present moment, the State engineers had under consideration a transformation of that apparatus. Yet, as regarded clearness of transmission of the voice, there was no system superior to that in working at Paris; still, the Administration had decided to give to the telephone service all the improvements necessary. M. Fouquier had complained that the State required a subscription for three years; that clause was rendered necessary in order to allow of the getting back of a little of the arrears. At the end of the third year the subscription would be annual. As to the obligation of the heirs to fulfil the engagements of the deceased subscriber, that was a consequence of the French code. The State reserved the right of breaking the treaty any day it suited it; in short, it wished to suppress the telephonic service of subscribers who should show themselves unseemly before the telephone ladies. The Administration would neglect no effort to satisfy its subscribers. All the complaints were the subject of an inquiry; but it was necessary that the public should take into account the primitive state of the apparatus at present in use, and should remember that it must give the State time to perfect it.

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Commenting on the above, *Le Soleil* says (and this gives a fair exposition of the views of the Press, excepting the official organs):—"Every constitution of a monopoly to the profit of the State is a menace to private interests. Thus, when it forcibly made itself master, for its own account, of the telephone lines created by a private company, it was foreseen that the proper use of the telephone would become impossible. That is what has happened; complaints have arisen on all sides, and have often appeared in our columns. Without entering into details of the complaints, they may be summarised in a few words: the apparatus does not work, and the staff works badly; when one desired communication with a subscriber it was necessary to surrender to obtain it; but at night, when the subscriber was asleep, the diabolical ringings of the bell made him jump from his bed; the staff assured him that 'all went well.' While laughing at the public the State has modified the conditions of subscription so as to make a draconian contract; the price and the minimum duration are excessive; the accessory obligations go almost as far as to destroy the inviolability of the domicile. M. Henri Fouquier brought to the tribune the protests of the victims of the State telephones; he discreetly advised the Minister of Commerce not to exasperate Parisian commerce by neglecting to improve an intolerable situation. 'Improvement,' said M. Tirard, 'certainly; on every rung of the administrative ladder we think of nothing but that.' To prove that, the President of the Council, Minister of Commerce, of Industry, of Posts, Telegraphs, Telephones, Colonies, &c., paid solemn homage to the regretted M. Coulon, who so short a time since took refuge in the Council of State; it is known that, as an improver, that functionary bore away the palm. Again, if the service had been pitiable since the substitution of the State for the company, that was the fault of the influenza; if the staff was crabbed the reason was the public was not polite; and, therefore, by way of punishment, the favour of subscription will be withdrawn from those subscribers who shall fail in respect to the lady telephonists. Finally, when the means of perfecting the *matériel* has been found, it will be said: 'The *savants*' brains are in labour, gentlemen.' As soon as they have brought forth some discovery the Government will claim credit for applying it. But there is no hurry. 'To-day, I say,' proclaims M. Tirard, 'the lines work admirably,' and, as before this assurance some chuckled and some murmured, the imposing orator went on with firmness: 'I know persons are to be found who will say the contrary; well, that is an absolute error.' There! we must teach them how to live, these telephone subscribers. Let them pay the amount of their subscriptions and hold their tongues; that is all that is allowed them by the State worker. As to the non-subscribers, they will only pay their portion of the sums voted. Pay, always pay, and never obtain anything but vexations, such is our lot; the public renders itself worthy of this by its inexhaustible patience."

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In connection with the above, a decree has just been published in the *Journal Officiel* by which every subscriber to a telephone line may obtain on application, if he prove his identity, the privilege of corresponding gratuitously, within the limits of that line, by means of the public cabins connected therewith. Non-subscribers may obtain the same privilege by prior payment of a subscription in accordance with the conditions of the Decree dated October 19th, 1889. The amount of this subscription per year is fixed as follows:—For the Paris lines, 80 francs; for the other subterranean lines, 60 francs; for aerial lines, 40 francs.

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## ON THE MULTIPLE RESONANCE OF THE HERTZ ELECTRICAL UNDULATIONS.

By MM. EDOUARD SARASIN and LUCIEN DE LA RIVE.

THE remarkable researches made by M. Hertz in electrical undulations have, we believe, been repeated in a large number of laboratories. We have ourselves for some little time been engaged in similar experiments, not, however, specially restricted to those which confirmed the results obtained by M. Hertz, and we now proceed directly to describe (*Comptes Rendus*) a point in these researches to which we have given greater attention, and as regards which we have succeeded in establishing some new results.

Amongst the experiments described by M. Hertz in support of his hypothesis of the undulatory propagation of electric induction, there is one which consists in fixing two brass plates in front of the two capacities of its primary exciter, from which plates there usually proceed two conductors of equal length, insulated at their extremities, parallel to each other and perpendicular to the axis of the primary conductor. The undulatory electric movement excited by this last is diffused throughout the length of these wires up to their insulated extremities, and is there reflected. The

clashing of the reflected waves with the direct waves gives birth to stationary waves, equidistant and separated from each other by fixed nodes. A circular resonator moved between these two wires, with its normal plane in their direction and its interruption towards the upper part, produces a spark which passes through the maxima and the equi-distant minima, alternately. By placing a primary conductor of 1·20 m. amplitude, for example, and a resonator of 0·75 m. diameter, in communication with it, we see at the furthest extremity of the wires that the resonator's spark presents a maximum denoting a reflection without alteration of sign. At 1·20 m. of this extremity, the spark disappears to reappear further on, disappears again at 4·20 m. reappears again, then disappears at 7·20 m., and so on. These intervening nodes of about 3 m. give the measure of the half of the total length of the wave corresponding to the primary conductor. Such was the experiment made by M. Hertz, and it is very easy to repeat it. By varying it in different ways we have obtained various results, which are not contradictory of his, but are complementary to certain points.

In the experiment just described, the resonator gives the length of the wave corresponding to the amplitude of the primary conductor, since, in order to obtain this, we have been careful to make use of a resonator of similar period. This latter gives the length of the wave of the primary, but, above all, it gives the length of its own wave. In fact, if we make use of circular resonators of any smaller size, of 0·50 m. circles and of 0·35 m. diameter for example, controlled by the action of the same primary, we no longer obtain nodes at equidistant points along the wires, but nodes of a different kind in closer proximity to the circle 0·50 m. than to that of 0·35 m. We observe that the resonator does not give the period of the primary, but quite another period, peculiar to it, and independent of the primary.

We carried out a great number of measurements with these three types of resonator. The general dispositions of the experiment being similar, we made considerable variations in the secondary circumstances, viz., the dimensions and disposition of the primary conductor, the length of the wires and the distance between them, the position of the resonator in relation to these wires, the employment of a single wire, or even of a copper tube in place of it, the addition or omission of the brass plates at the extremity of the wires nearest the primary ; and in every case the position of the nodes disclosed by the same resonator, estimated from the farthest extremity of the wires was the same.

The arrangement finally adopted by us was to take two copper wires of 1·8 mm. diameter and 10·60 m. length, well fixed and drawn tight. The circular resonator moved along a graduated scale. In order to determine a node we indicate in the dark portion the two points at which the extinction of these nodes takes place, the average position of which is afterwards read upon the scale.

The following tables give the results of the measurements of a series obtained in this way, always adhering to the same primary of two square brass plates of cm., and put in action by means of a Ruhmkorff coil 20 cm. sideways, having between them a space of 48 of 55 cm. length :—

DISTANCE OF THE NODES FROM THE FREE EXTREMITY OF THE WIRES.

| | Circle of 35 cm. | | Circle of 50 cm. | | Circle of 75 cm. | |
|---|---|---|---|---|---|---|
| Distance. | Observed. | Calculated. | Observed. | Calculated. | Observed. | Calculated. |
| | m. | m. | m. | m. | m. | m. |
| 1st node | 0·60 | 0·60 | 0·78 | 0·78 | 1·24 | 1·24 |
| 2nd „ | 2·03 | 2·07 | 2·73 | 2·67 | 4·19 | 4·23 |
| 3rd „ | 3·56 | 3·54 | 4·46 | 4·56 | 7·23 | 7·22 |
| 4th „ | 5·09 | 5·01 | 6·52 | 6·45 | ... | ... |
| 5th „ | 6·45 | 6·48 | 8·35 | 8·34 | ... | ... |
| 6th „ | 7·90 | 7·95 | ... | ... | ... | ... |
| 7th „ | 9·42 | 9·42 | ... | ... | ... | ... |

Average :—Of 6 intermediate nodes, 1·47 ; of 4 ditto, 1·89 ; of 2 ditto, 2·99.

| | Distance of the first node. | Half circumference. |
|---|---|---|
| Circle of 0·35 ... ... | 0·60 ... | ... 0·55 |
| „ „ 0·50 ... ... | 0·78 ... | ... 0·78 |
| „ „ 0·75 ... ... | 1·24 ... | ... 1·17 |

which seems to indicate that the reflection in the circle at any part of the interruption is accomplished in a manner analogous to the reflection at the extremity of the wires, the two poles of the resonator corresponding to two points of maximum vibration of contrary signs.

As M. Hertz points out, if we place a junction wire at the extremity of the wire it produces a node there. By placing a brass disc at the free extremity of each of the two wires we obtained the same result, but the dimensions of the intermediate nodes remained always the same with the same resonator.

If we attach to the extremities of the resonator, at any portion of the interruption, small bits of copper wire increasing in length, the effect of which is to augment its amplitude, we get with the same circle equivalent quantities of intermediate nodes. Let us add that we do not succeed in establishing the existence of nodes with an (open) rectilineal resonator. These facts demonstrate, we think, that it is possible to detect a wave of any size, within certain limits, in the electric oscillatory movement emanating from a Hertz exciter, the size of the wave, of which the points of maximum vibration and the nodes are ascertained in the above-mentioned experiment, only depending upon the dimensions of the resonator employed for that purpose. We are constrained to admit that the undulatory electric system which is produced by such an exciter contains, within certain limits, all the possible lengths of the wave, each resonator choosing from this complex whole, in order to exhibit the stationary waves, the undulation whose period corresponds with its own.

This, therefore, may be called multiple resonance of electric undulations, since we have already given the name of resonators to the apparatus intended to bring out the vibratory movement.

At first sight there is nothing astonishing in this multiplicity of the undulatory electric movement, but there seemed to us to be a certain interest in establishing it.

M. Cornu makes the following observations on the above :—

These results show with what reserve the theoretical consequences deduced by M. Hertz from his experiments ought to be received, particularly in what concerns the measure of the speed of the propagation of induction in a rectilineal conductor.

The theory of M. Hertz rests in fact upon two distinct principles :—

1. Upon the fundamental hypothesis that the spark of the inducing bobbin produces a disturbance of a *fixed period*, which is determined solely by the construction of the exciter.

2. Upon the *observance of an apparent periodicity* in the electric condition of the induced wires.

Then the author, following up the assimilation of the induced wire with an elastic vibrating column, imagines a correlation to exist between this hypothetical periodicity of the exciter and the apparent periodicity of the electric condition of the wire ; he determines the nodes and the points of maximum vibration (that is to say, the analogue of a length of wave $\lambda$) by means of an auxiliary apparatus or electric resonator ; on the other hand, a calculation founded upon contestable bases gives him the oscillatory period, T, of the primary exciter, from which he draws the following analogy :— $\lambda = V T$, the speed, V, of the propagation of induction in the wire, corresponding to the speed of the propagation of an electric wave, a speed which, in certain cases, is identical with the velocity of light.

From the experiments made by MM. Sarasin and de la Rive, we gather that the oscillatory condition of the electric charge of the induced field, instead of being invariable, as the vibratory condition of an elastic column subjected to an action of uniform and settled period ought to be, is essentially dependent upon the resonator with which we examine it.

This result is extremely serious for M. Hertz's theory ;

in fact, the sole experimental element, which is fixed and incontestable, should appear to be the value of the length of the wave of the electric propagation in correlation with a well-defined period of the exciter.

We now learn that this length of wave is variable, according to the apparatus of observation employed; M. Hertz's theory is, therefore, hemmed in by dilemma, of which the alternatives are equally vexatious; the experiment showing that $\lambda = V T$ is variable, or else it is the period, T, which is not fixed and uniform, a conclusion which is contrary to the fundamental hypothesis in the author's original idea; or else it is the factor, V, which is variable alike with the instrument of observation employed, a deduction which is absurd, since V should represent the speed of the propagation of induction, that is to say, a specific constant. We see the great prudence of proceeding as MM. Sarasin and de la Rive have, that is to say, of examining with precision the very curious experimental method imagined by M. Hertz, before dreaming of offering it as a demonstration of the identity of electricity with light.

## THE COST OF MUNICIPAL ELECTRIC LIGHTING IN PARIS.

M. PAUL BROUSSE, a member of the Paris Municipal Council, has just issued a report in which he gives the following particulars as to the net price of the electric light in connection with some of the installations belonging to Paris city authorities:—

Hôtel de Ville.—The electric lighting of the Hôtel de Ville comprises 500 incandescent 16-candle lamps and 4.000 10-candle lamps, which are used expressly for *fêtes*. The *materiel* includes the following: Two Edison dynamos of 110 volts and 200 ampères, and five Gramme dynamos of 110 volts, three of which are of 250 ampères and two of 500 ampères. The lamp hour of 16 candles cost 8·4c., and the carcel hour 5c. The lighting of the Hôtel de Ville is only used a few months during the year, and the whole of the lamps only three or four times. Place du Carrousel.—Since July, 1889, the Place du Carrousel has been lighted by Pieper lamps, fed by the Edison station of the Palais Royal; the lamp hour (probably 30 carcels) costs 63 c. Parc Monceau.—The Parc Monceau is lighted by 20 Jablochkoff candles, fed by three alternating current Gramme dynamos. The price per lamp hour is 48 c., or 2.4 c. per carcel hour. Buttes Chaumont.—In the park of Buttes Chaumont there are installed 46 Brush regulators, at 40 carcels each; in addition, 16 incandescent lamps of 16 candles are used for lighting a restaurant. The carcel hour costs 1 c. The Halles Station.—Though no accurate data are yet obtainable, M. Meyer estimates that the 100 watt hour costs 5 c. or 6 c., including all expenses excepting rent. Grand Boulevards.—During the Exhibition, the lighting of the Grand Boulevards was carried out by the Popp and Edison Companies and the Rothschild-Marcel Deprez Company. The expenses were as follows: Popp Company, 40 regulators of 75 carcels (10 ampères), 1 fr. 5 c. per lamp hour. Edison Company, 37 regulators of 75 carcels (40 ampères), 82 c. per lamp hour. Company for the Transmission of Power, 27 regulators of 75 carcels (10 ampères), 82 c. per lamp hour. The whole of the money devoted to municipal electric lighting amounted to 782,750 francs, 100,000 francs of which were spent in trials.

**Telegraph Work on the Midland.**—At the recent meeting of the Midland Railway Company the chairman, in referring to the work of the Telegraph Department, mentioned that during the past year the number of messages was nearly 10 millions, an excess of two millions—20 per cent.—over the previous year's work. This is a very satisfactory state of affairs.

## SUBMARINE CABLE BORERS.

AT a recent meeting of the Zoological Society, Captain D. Wilson-Barker, R.N.R., F.Z.S., of the Silvertown company's staff, gave a very interesting description of various forms of boring molluscs met with during some cable repairs he had been engaged in. He also exhibited several specimens of these molluscs; as it is supposed that among them are two or three new varieties, these specimens have been placed in the hands of the British Museum authorities for classification. From Captain Barker's remarks we make the following extract, as being of special interest to telegraph engineers:—

"The presence of the teredo in submarine cables has for many years been well known to telegraph engineers, but so far as I am aware, the attention of zoologists has not been drawn to this particular habitat of the boring mollusc. With the permission of Major Wood, managing director of the Western and Brazilian Telegraph Company, I am able to lay some specimens of the teredo before the Society this evening. They were taken from the cable between Rio de Janeiro and Bahia in lat. 22° 11′ S., long. 40° 22′ W., at a depth of 20 fathoms.

"It may be of interest to remark that several teredo faults were discovered in this particular neighbourhood, thus rendering localisation a very difficult matter, the more so since there existed on the outside of the cable no sign indicating the presence of the borers.

"The specimens of cable exhibited illustrate the exact positions of the teredoes, and it will be observed that they must have penetrated between the sheathing wires when in the embryo state, thus planting themselves on the jute into which they afterwards bored. The jute is tanned by a special process before it is laid on the core, and it is therefore remarkable that these molluscs should be able to bore through this tough material impregnated with a chemical solution, and then scoop pieces out of the gutta-percha core.

"Together with the teredo I found another bivalve, and the minute hole in one of the teredo valves shows the presence of some other boring mollusc, which apparently fed upon the teredo itself.

"I may mention that in another cable I have found specimens of a small Pholas, but in this case the sheathing wires were bird-caged out, thus affording free communication with the jute covering."

## THE ELECTRICAL CONDUCTIVITY AND RESISTANCE OF MERCURY.

IT has long been known that the electrical conductivity of metals decreases according to their temperature; this decrease of conductivity involves a corresponding increase of resistance; thus the resistance of such a uniformly cylindrical conductor as a wire, for instance, depends directly upon its length, $l$, inversely upon the area of its cross-section, $a$, and inversely also upon its specific conductivity—relations which are conveniently expressed by the formula

$$R = \frac{l}{a\,c}.$$

It is true, however, that the electrical conductivity of some bad conductors or insulators increases with a rise of temperature, but, as a general rule, the law as stated holds good; thus we find constantly in practice that a heated wire or dynamo-electric machine increases the resistance in the circuit of which it forms some part. Copper is a typical example of a conducting material whose resistance is largely increased as its temperature is raised; that of carbon, however, seems to diminish. Forbes was one of the earliest to experiment in this direction.

The researches of Arndtsen seem to indicate that the resistance of a simple metallic conductor

in the solid state is very nearly directly proportional to its absolute temperature; this was pointed out by Clausius (*vide Ann. Phys. Chem.* [1], t. 104, p. 650); there are, however, two well-marked exceptions, namely, mercury and iron.

The arguments used by Clausius have been supported by Werner Siemens, who confirmed the conclusion arrived at, but qualified it by one condition, namely, that the resistance of the metallic conductor is nearly proportional to its absolute temperature only when the metal is not near the melting point.

When metals melt, their electrical conductivities fall suddenly; it would seem therefore that the state of aggregation of any substance has some influence upon its electrical resistance. This subject has received much careful attention from L. Grunmach, who has contributed several interesting papers to the *Annalen der Physik und Chemie.*

In a memoir (*Ann. Phy. Chem.* [2], XXXV., p. 764,) a short time ago, it may be remembered that Grunmach described a number of experiments which he had undertaken in order to obtain some observations of the resistance of mercury at temperatures ranging from − 90° C. to + 20° C. He found that the value of the temperature coefficient of liquid mercury is 0·00086; this value agrees fairly well with some other determinations; thus, Werner Siemens found 0·00095, whilst Mascart, Nerville, &c., place the value of the temperature coefficient at 0·000882.

As we observed before, when metals melt, their conductivity rapidly falls, and, consequently, the resistance undergoes a rapid increase; this phenomenon is well seen in the liquefaction of solid mercury, and Grunmach at first estimated this increase at about 1·5 times the original resistance. As a result, however, of further investigation, he now finds that the resistance of mercury immediately after liquefaction is 2·5 and not 1·5 times the value of the resistance of the solid mercury immediately before melting.

The paper recently published (*Annalen der Physik und Chemie*, t. XXXVII., p. 508), in which this research is described, compares these late figures with those obtained by Cailletet and Bonty. The value 2·5 is considerably smaller than that obtained by these physicists, smaller also than C. L. Weber's determination; this discrepancy he considers to be due to the change in volume which the mercury experiences, namely, expansion during its passage from the solid to the liquid state; further, the calibration of the tube bears some influence, variations in the above affect the apparent change of volume, and as already stated, the change of volume affects the resistance of the mercury. The determination of the correction factors for these irregularities is now occupying the attention of Herr Grunmach.

The temperature coefficient which was valued at 0·00086 was observed during the first investigation not to remain constant between the temperatures −90° C. and −40° C. An examination of the following table shows a steady decrease in the value of the coefficient as the temperature diminishes.

| Temperature. | Temperature coefficient. |
|---|---|
| −40° ... ... −50 ... ... ... | ... 0·00226 |
| −50° ... ... −60 ... ... ... | ... 0·00134 |
| −60° ... ... −70 ... ... ... | ... 0·00111 |
| −70° ... ... −80 ... ... ... | ... 0·00078 |
| −80° ... ... −90 ... ... ... | ... 0·00037 |

The value of the temperature coefficient and this habit of decreasing have not been seriously affected by the results of the new investigation; the conclusion formerly arrived at, namely, that the temperature coefficient of decrease of resistance for solid mercury diminishes from the temperature of solidification down to −80° C. is confirmed, as will be seen from the figures in the following table which are those obtained in the more recent experiments.

| Temperature. | Temperature coefficient. |
|---|---|
| −40° ... ... −50° ... ... ... | ... 0·0023 |
| −50° ... ... −60° ... ... ... | ... 0·0013 |
| −60° ... ... −70° ... ... ... | ... 0·0011 |
| −70° ... ... −80° ... ... ... | ... 0·0008 |
| −80° ... ... −90° ... ... ... | ... |

These results afford additional evidence in support of the statement made in the early part of this paper, namely, that mercury is an exception to the law deduced by Clausius from Arndtsen's investigations; which law asserts that the electrical resistance of a simple metallic conductor in the solid state is roughly proportional to the absolute temperature.

Any new information concerning the electrical behaviour of mercury must needs be of importance as well as of interest because of the part it plays in practical measurements, the Congress ohm being the resistance of a column of freshly distilled mercury, 1 square mm. in cross section and 106 cm. in length at 0° C. With regard to this length it was considered practically certain at the time the unit of resistance was established that it was a little too short, for the mean of all the values published before the Paris Committee met was 106·02 cm. A very careful investigation by F. Kohlrausch, an account of which recently appeared in the *Annalen der Physik und Chemie*, seems to show that the true length of the column of mercury lies between 106·2 and 106·3 centimetres.

## VOLT AND AMPERE ANALOGIES.*

By T. O'CONOR SLOANE, Ph.D.

CONSIDERABLE difficulty is experienced in appreciating the true relations of electric units. Any analogies drawn from more familiar or concrete things are useful if they are really apposite. In the cut are shown the lines of a simple experiment often used to show the phenomenon of torsion, which may be employed to illustrate the relations of potential difference, usually expressed in volts, to an electric circuit and to the current produced in it by the potential difference in question.

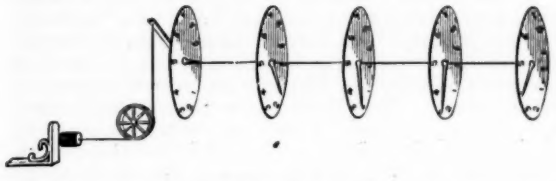
A vertical wire is attached at its upper end to a pointer moving over a dial graduated as shown. To its lower end a lever is attached, to whose end a thread passing over a pulley and carrying a weight is fastened. Several intermediate dials are placed at even distances, the wire passing through their centres. To the wire, pointers are attached, one for each dial. The whole is so adjusted that when the weight rests on its support and the thread is tight, all the pointers stand at zero.

If the upper pointer is turned around, the others will share in its rotation to an extent inversely proportional to their distances from it. Suppose, in the arrangement shown, that the first pointer is turned to 4 and that the weight is just raised. Then the second pointer will reach the figure 3, the third pointer the figure 2, the fourth pointer the figure 1, and the lowest will move only an inappreciable distance. If we imagine the wire to be part of an electric circuit, and the rotations of the pointers to indicate voltage, we have an excellent illustration of fall of potential. The raising of the weight represents the development of a current. Thus the first pointer moving over four divisions, while the last does not move, indicates a difference of potential between the two extreme points of four volts or other unit. Taking the middle of the wire where the pointer stands at 2, a difference of potential of (4−2=2) two volts between the upper end and centre of the wire, as well as between centre and lower end, is indicated. The same rule of uniform drop of potential will hold for all intermediate points. The wire is supposed to be structurally uniform, and references to proportional distances on an electric circuit refer, of course, to what may be termed electric distances, measured by resistance, and not necessarily by lineal feet or inches.

The ampère is the unit of intensity of current; it is not a unit of quantity, except indirectly. It is the current which a difference of potential of one volt will establish through a resistance of one ohm. It has, in ordinary measurements, one very close analogy that

* *Scientific American.*

seems to have been seldom utilised in text books. In the Western States and Territories the flow of water is measured by what is known as the "miner's inch." It is the flow of water that will take place through a hole 1 inch square, in a 2 inch plank, under a head of 8 inches of water measured from the lower edge of the opening. The analogy is excellent between this and an electric current. The head of water represents



the difference of potential, say, of one volt, the opening in the plank represents a conductor of defined resistance, say, of one ohm, and the water escaping, running out at the rate of one miner's inch, represents the current produced under the conditions, or one ampère. An ampère flowing for one second gives a quantity of electricity termed one coulomb; the miner's inch flowing for one second gives a quantity of water termed 0·1937 U.S. gallon.

Both units can be used without reference to time to indicate the strength in one case of a current of water, in the other case of a current of electricity. It shows how incorrect it is to speak of a current of any number of "ampères a second," instead of simply "ampères." If seconds are to be used, then the current should be spoken of as equal to so many "coulombs per second." Water flows at the rate of so many miner's inches, without any reference to time.

## DISTRIBUTION BY COMBINED ALTERNATING CURRENT AND STORAGE SYSTEMS.

By R. FREDERICK YORKE, A.I.E.E.

IT is generally conceded that electricity can be more effectually distributed—especially in districts where the consumers are scattered—by means of the alternating current system than by any other method.

On the other hand, those who advocate the adoption of a low pressure continuous current system rely on the advantages of storage and the facility of supplying current for motive purposes, to more than compensate for the greater cost of supplying current for electric lighting.

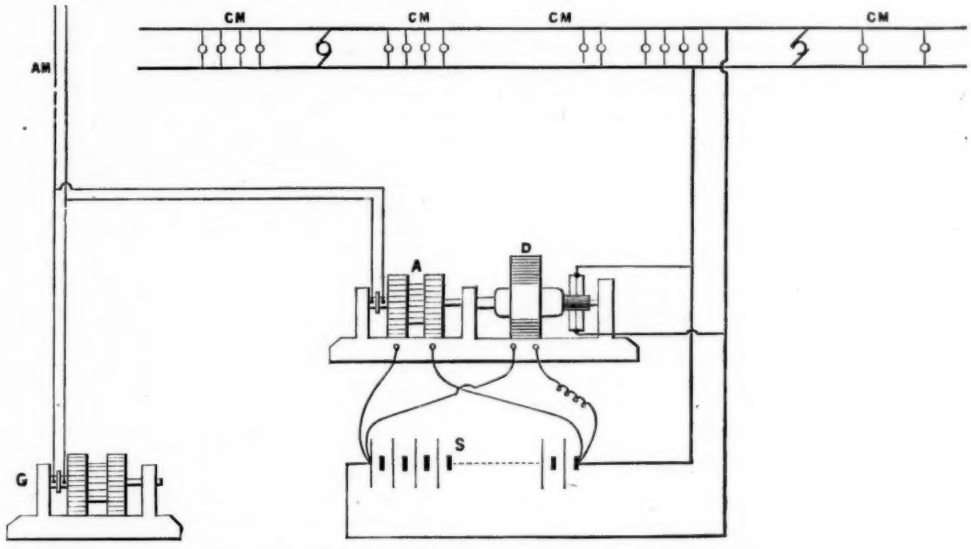
It has occurred to the writer that if a system could be devised which, while retaining the distributive powers of the alternating current, would also possess the many advantages of the low pressure continuous current, a distinct advance would be made in the commercial distribution of electricity.

The following is a brief description of a method which claims to accomplish this result:—

The district or town to be supplied by electricity is provided with one or more generating stations. These supply alternating currents at high pressure direct to a number of sub-storage stations. Each sub-station contains apparatus for converting the high pressure alternating current into a low pressure continuous current, and it is the latter only which is supplied to consumers for electric lighting or motive purposes.

The requisite plant in each of these sub-stations consists of an alternating current machine (or alternator) coupled mechanically direct to a continuous current dynamo. A set of storage cells is also provided, and the field magnets of both alternator and dynamo are excited from the battery, the strength of magnetising current being regulated by adjustable resistances.

In order to start the apparatus the accumulator is




G, Alternating current generator; A M, Alternating current mains; A, Alternator; D, Dynamo; C M, Mains supplying continuous low pressure current; S, Accumulators.

first switched on to the dynamo, which runs as a motor, driving the alternator. As soon as the speed is sufficiently high, the alternating current from the high pressure mains is switched on to the alternator, which now in turn becomes the motor driving the dynamo, and by regulating the resistance in the circuit of the field magnets of the latter the desired continuous current for charging the accumulator is obtained.

It is not intended that the full current shall always go through the accumulator. It will probably be advisable to provide storage for an output of 20 to 30 per cent. of the maximum demand. During the chief lighting hours the dynamo will supply the low pressure mains direct, and the accumulator will only discharge during the period of maximum demand, and also late at night when the machinery at the generating station is stopped.

One noticeable feature is the great ease with which the output of the continuous current is regulated by adjusting either automatically or by hand the magnetising current of the dynamo. This is due to the good regulation of the alternator, which drives the dynamo at a constant speed independently of variations in the load.

It was at first thought that when starting the converting apparatus it would be necessary to introduce some device for showing when the alternator was in

synchronism with the external current. Experiments, however, carried out at Messrs. Siemens works in December, 1888, showed that it was only necessary to run the alternator at approximately the right speed before switching on the alternating current.

It may occur that a consumer is at too great a distance to make it pay to carry the low pressure mains so far. In that case he would be supplied from the alternating mains, a transformer being employed in the usual manner.

There would still be no necessity for keeping the generator running on this account, as by still further weakening the magnetic field of the dynamo the accumulator will discharge, driving the dynamo as motor. The alternator now becomes a generator, supplying alternating current to the high pressure mains.

This system of distribution, therefore, possesses great flexibility; for instance, in the case of a company already supplying alternating current over an extended area, there will probably be districts where the consumers are numerous and fairly close together; or again, where current for motive power could be supplied advantageously, it would then be perfectly easy to provide such district with a storage station to supply continuous currents in that neighbourhood, and without necessarily increasing the plant at the generating station.

Briefly stated, the following are the chief advantages of the combined alternating current and storage system:—

1. Less powerful generating machinery required, since both dynamo and accumulator supply current during the period of maximum demand.

2. Greater economy in the supply of current due to—

(*a*) The useful employment of machinery in the day-time, the engines never remaining idle.

(*b*) The saving effected in wages, the generating station being shut down for 6 to 8 hours every night.

(*c*) No transformers being employed (save in the remote contingency before mentioned), there is consequently no waste of current when the lamps are not alight.

3. Facility of supplying current for motive purposes.

4. Maintenance of constant pressure throughout the district, ensuring absolute steadiness and regularity of the light and consequently longer lifetime of the lamps, and greater satisfaction to consumers.

5. Security against extinction of the light in the case of a breakdown at the generating station.

## A NEW ELECTRIC CONDUIT FOR STREET CARS.*

RECENT developments in electricity have demonstrated the necessity of provision for greater safety in the use of heavy currents. It has been shown that arc light currents are particularly dangerous. It is known also that objectionable and even dangerous shocks may be given to men and animals by such currents as are used in the propulsion of street cars.

We describe a conduit for electric railways in which all dangers of this kind are avoided. In this system the conductor is entirely out of reach, and an electrical connection can be established only upon the portion of the railway occupied by the car. A clear understanding of this invention may be had by examining the parts of the railway and car from which portions are broken away to show the interior.

The car runs upon the railway track and is provided with an electric motor, which is geared to one of the axles of the car in the usual way. Underneath the car is suspended a series of electro-magnets which extend downwardly to a point near the electrical conduit. These electro-magnets are inclosed to protect them from dirt or injury, and also to prevent them from gathering particles of iron.

The conduit is formed of a tube having a top made up of sections of non-magnetic material, insulated from each other and the body of the conduit. In the bottom of the conduit is arranged a conductor, which is thoroughly insulated. To the conductor are attached standards, to which are secured flat springs, carrying at opposite ends pieces of iron, forming armatures. The normal position of the springs is horizontal, but when the magnets pass over the springs, they are raised up into contact with the sections, producing an electrical connection between the conductor and these sections.

To the bottom of the car are attached brushes, which are adapted to take the current from the sections as the car passes along. The current passes from the brushes through the motor, a small portion of it being shunted through the magnets. The current returns to the generator through the wheels of the car and the railway rails. It will be noticed that an electrical connection with the conductor can be established only when the armatures carried by the springs are drawn up by the magnets into contact with the sections, so that anything touching the sections which are not in the electric circuit will be no more affected than it would be by contact with the paving stones. As the car passes along, the armatures carried by the springs are released and the springs returned to their normal position. The surfaces of the sections are cleaned by brushes located at the ends of the car.

Not only is perfect safety secured by this improved system, but the accumulation of mud and water in the conduit is avoided by sealing it from end to end. As the sections are insulated from the conduit and from each other, the current cannot be transmitted from one section to another. It is the intention of the inventor to maintain a constant circulation of air through the conduit, to prevent the condensation of moisture, and thus avoid the accumulation of water.

This system consists almost entirely in the conduit and the electro-magnets and brushes carried by the car. Any good electrical motor can be applied to the car, and the current may be supplied by any dynamo of approved construction.

The current is carried directly to each car, and the chances of leakage are reduced to such a degree that the loss from this cause may be left out of calculation. This system also has a great advantage on single track roads, as it may be applied to turnouts and switches without any complication, and the conduit may be carried around sewer manholes and other street obstructions. The difficulties arising from the use of a slotted conduit are entirely avoided.

Mr. Harry W. Smith is the inventor of this system, and the Smith Electric Conduit Company, of New York, are the promoters of the invention.

* *Scientific American.*

## ON THE MECHANICAL ACTION OF VARIABLE CURRENTS.

M. J. BORGMAN writes (*Comptes Rendus*): In attempting to repeat with the aid of the restricted resources of a laboratory, the interesting experiments made by Prof. Elihu Thomson, and so brilliantly demonstrated at the time of the exhibition of 1889, I obtained some new results which I have now the honour to lay before the Academy.

A ring made out of thick copper wire was suspended in the place of the beam plate of a pair of scales and the balance maintained by means of weights; below this ring was placed concentrically a vertical bobbin, containing a copper wire of 2·5 mm. diameter (the height of the bobbin was 120 mm., its interior diameter 43 mm., its exterior diameter 120 mm.). The bobbin may or may not be furnished with a massive bar of iron or formed of iron wire. The current was supplied by accumulators; a commutator which was kept in motion at the speed of nearly 1,000 revolutions per minute by a Breguet electric motor, changed the current's direction twenty times per revolution. Even with a current of half an ampère the repulsion of the ring was clearly marked; it was less so when the

bobbin was without the iron bar. On substituting for the ring a horizontal disc of similar dimensions or by a tube of the same metal suspended in the cylindrical cavity of the bobbin, we observed considerable repulsion, much less, however, in the case of the tube than in that of the disc or ring.

On substituting for the commutator a simple interruptor, affording a number of interruptions per minute equal to that of the current's inversions, we noticed similar repulsions, but of less intensity. It was upon the liquid surface of a sheet of mercury that I observed the most interesting phenomena. The bobbin made use of was merely a coil of insulated wires, connected to each other by threads and deprived of the extraneous portions of metals which might interfere with the phenomena to be observed. A glass basin with a flat horizontal bottom, containing mercury was placed as concentrically as possible above the bobbin, and the surface of the liquid lightly powdered over with lycopodium. A few moments after the closing of the alternating or merely intermittent current, as the case may be, the motions of the particles of lycopodium plainly evinced the presence of two circular currents of mercury moving in opposite directions, which combined to form a single diametral current.

These eddies are most marked when the thickness of the mercury is least; in fact, just sufficient to cover the bottom of the base. They are less marked with intermittent than with alternating currents; the presence of the iron bar increases the intensity of the eddying movement.

If we bring about a want of symmetry in the field of the bobbin deprived of its bar, by inserting a thin copper disc beneath the basin excentrally as regards its centre, we notice two eddies, the current of which is towards the disc. By inserting two or three discs beneath the basin, we get four or six eddies whose lines of demarcation are directed along the diameters of the discs. By placing a metal band diametrically beneath the basin we obtain four eddies, one of whose lines of demarcation is normally directed along the band, the other being parallel to it; the currents of mercury directed towards the centre flow along the first direction. We obtain two strong eddies in the direction of the centre of the bobbin by placing the basin of mercury slightly excentrally upon the bobbin containing the iron bar.

Generally speaking, the mercury currents flow towards where the metal is situated under the basin, and form eddies, the more intense of whose parts are situated nearest to this spot.

By placing beneath the basin a flat ring composed of three equal copper, brass, or zinc sections, we obtain six eddies of different intensities. The pair corresponding to the copper is the most energetic, that of the zinc being barely perceptible, even with a current of more than 2 ampères.

We obtain no movement of mercury if the basin, being smaller than the central vacuum of the bobbin, is placed concentrically above it.

The formation of the eddies above the bobbin alone, *i.e.*, without the bar or the metallic plates, is, according to my experiments, explained by the want of homogeneity of the wire and the imperfect symmetry of this bobbin's form.

By placing the bobbin horizontally under the basin, so that only a portion of the mercury is above the bobbin, we obtain two eddies with a line of demarcation above the bobbin's axis. We likewise obtain two eddies by placing the basin alongside the vertical bobbin; but in this case the intensity of movement of the mercury will be very slight. The mercury need not entirely cover the bottom of the basin; the same effects will be obtained with isolated drops.

If we sprinkle iron filings upon the mercury, we observe a tendency in the larger particles to conform to the direction of the lines of force whilst submitting slightly to the eddying movement of the mercury. The most minute particles splutter in all directions, like liquid drops in the spheroidal state.

## SMALLEST CENTRAL STATION IN THE WORLD.

THE policy of erecting central stations in very small towns now appears to be gaining in favour abroad, but in this country such projects are only carried out in large cities. A few weeks ago we recorded the establishment of a central station in the town of Pont-de-Vaux, in the Department of Ain, France, where the population is only 3,500, and we have now to announce the establishment of a central station in a town containing only 2,500 inhabitants. This is in Germany, at Gummersbach, a small town well known in connection with the woollen industry, and having a length of about three quarters of a mile. The station possesses certain features of interest. A boiler works and two large spinning mills are situated in the town, whilst in the small suburb, Mühlensessmar, about half a mile off, four other large spinning mills exist. The inhabitants had long considered the advisability of improving both the public and private lighting, and on account of the fairly satisfactory light given by the petroleum lamps employed, the various projects for the erection of gasworks were never seriously entertained. Eventually the idea was conceived of establishing a central electric light station, and, after due consideration, a contract was entered into between the town authorities and Messrs. Müller and Einbeck, of Hagen, Westphalia. The agreement stipulated that the light should be available both day and night, and it was therefore necessary to employ accumulators. The station was inaugurated a few weeks ago, and the following details may be of interest:—The station has been erected close to that end of the town which is nearest to the suburb, whilst both in the latter, and also at the other end of the town, a battery of Tudor accumulators has been installed. The distributing system has been laid out on the two-wire system for a maximum of 2,000 lamps, there being four distributing points; and the conductors are of naked copper wire carried on insulators fixed to wooden poles, the service wires branching direct from the mains. In the station are installed two portable combined engines and boilers, each of 40 H.P., but these will eventually be replaced by fixed engines. The two dynamos, which have an output of 130 ampères at 220 volts pressure, are driven by belting direct from the engines. A switchboard and regulating apparatus are fixed to the wall, and in another room a battery is erected, whilst, as already mentioned, a second battery is installed near the other end of the town, and a third set of cells in the suburb. The two distant batteries are charged from one dynamo, and the station battery by the other. On an increase in the demand taking place in the suburb, the charging cable is disconnected from the battery, and by means of a switch works direct on the distributing main. The loss in transmission is the same as if the battery were being charged, and the dynamo, which has at the same time been uncoupled from the other distant battery, supplies about one-third of the suburban demand. The second dynamo is simultaneously disconnected from the station battery, and then, in conjunction with the town battery, feeds the lamps direct; the accumulator in the station only acting as a regulator. Automatic regulation has been adopted throughout, and the undertaking has been very successful. A noteworthy feature of the station is the fact that the inhabitants have largely adopted the light, 1,300 lamps being now installed, although the local works are, as yet, not supplied with many lamps. The price for current is about $\frac{3}{8}$ths of a penny per 16 C.P. (nominal) lamp per hour; but to the business establishments a reduction of 25 per cent. is made. The streets are lighted by incandescent lamps, and the new Tudor electricity meter is employed for the first time in connection with this station.

## LONDON MANSION LIGHTING.

A SMALL electric light installation has been put up on the premises, 55, Victoria Street, Westminster, S.W., of the Maxim-Weston Electric Company, Limited. The engine room is situated in a detached building in the basement at the back of the premises. There is installed a 20 H.P. Stockport gas engine, which drives by means of belting a length of countershaft on which are fixed four pulleys. One of these is for the engine belting, two are used for operating two dynamos by belting, whilst the fourth actuates a pump, which in turn operates a lift. There are two Maxim-Weston dynamos running at 1,200 revolutions a minute, the output of each being about 180 ampères at 50 volts pressure. A small switchboard will shortly be put up. The dynamos are used for charging accumulators, and there are installed three sets of 27 cells each, of the E.P.S. L 31 type. Two of these sets are located in the basement, whilst the remaining 27 cells form a battery situated in the basement of St. Margaret's Mansions, which adjoin. These mansions and the whole of No. 55 are lighted by about 300 16-C.P. lamps, including several installed in the Penny Bank, next door to the mansions. The current from one battery is employed to illuminate the lamps on the staircases and the company's offices, whilst the remainder of the lamps throughout the various private offices and dwellings are supplied with current from the other two batteries The conductors are laid in wooden moulding and local switches are provided, so that the lamps may be switched on or off as desired. The secretary's office contains about twenty lamps, most of which are arranged in the form of a ring suspended from the ceiling. The shades and protectors of the lamps comprising the ring are of various kinds, and of a high-class make, suitable for halls, drawing-rooms, &c. The installation might be termed a miniature central station, and one feature in it is the fact that the various offices, &c., are, now that the electric light is available, more easily let. It may be mentioned that this plan of lighting mansions and other establishments containing a large number of offices or dwellings is greatly gaining in favour, as most would-be occupiers prefer the electric light to gas. The policy of erecting an installation in large buildings, and charging for the offices a rent which covers the cost of lighting, although it is nominally stated that the electric light is given gratuitously, is now being gradually adopted, one instance being in a large building not half a mile from our office. Another similar feature which is becoming prominent is the lighting of whole estates by electricity, and about one of these we may have something to say shortly.

## NOTES.

**The Electric Light at Bournemouth.**—At the last meeting of the Bournemouth Commissioners, the lighting committee reported the receipt of a letter from the Board of Trade, enclosing a copy of the report of their inspector, Major Cardew, on his recent inspection of the installation of the Brush Electrical Engineering Company, and also forwarding a copy of a letter sent by the Board to that company, calling upon them to carry out the alterations mentioned in the report. The engineer of the company had informed the committee by letter that they were in communication with the Board of Trade as to carrying out the alteration. The chairman of the committee stated that Major Cardew came to Bournemouth and inspected the plant, wire, &c., of the installation, and had reported certain cases in which the Board of Trade regulations had not been complied with. The Board of Trade, the chairman of committee added, seemed determined that their regulations should be strictly carried out.

**Lighting of the Inner Temple.**—The extension of the electric light installation at the Inner Temple has now been completed and tested, and the whole of the plant is found to run most satisfactorily. The work has been carried out by Messrs. Drake and Gorham, who were connected with the Inner Temple previous to the commencement of the large scheme which was started by Mr. Sennett and afterwards abandoned. The additions consist of a 20 H.P. (nominal) Marshall boiler, which supplies steam to a Willans engine coupled direct to a slow speed dynamo. The steam is carried into an expansion chamber and then through a separate pipe to the top of the building where the condensed water is disposed of. The flue is carried some distance underground, and afterwards through an iron stack cased with brick to comply with the requirements of the local authorities. A third battery has also been installed, and the wiring of the hall has been overhauled and extended. The light has also been carried throughout all the public offices and robing rooms. The special precautions to prevent noise or nuisance to the neighbours have been successful in every way, thus affording another proof of the fact that electric light installations can be put down in the quietest neighbourhoods without causing nuisance if the proper precautions are taken.

**Hotel Lighting.**—The Hotel Albemarle, the handsome new building in the Renaissance style at the corner of Albemarle Street, Piccadilly, is lighted electrically.

**Electric Lighting in Natal.**—Complaints are made in Pietermaritzburg of the excessive rate of charges which the Corporation is trying to obtain from private customers. The promoters of the scheme contend that the Corporation cannot adopt a system of lighting which will include a supply to private consumers; but that contention is said to be negatived by the example of many English boroughs. A maximum of 2s. 6d. per unit means about three times the cost of lighting by oil lamps.

**The Lighting of Cologne.**—Of the light schemes submitted the Town Council has adopted one of alternating currents. The station will be in the centre of the city, and will have a capacity of 5,000 incandescent lamps.

**Tabernacle Lighting.**—The new Brooklyn Tabernacle is to be lighted by electricity.

**Cathedral Lighting.**—The Minster, at Ulm, is to be lighted by electricity on the occasion of its completion in August or September.

**Opposition to City Lighting.**—The County Council will present a petition against the City Electric Lighting Bill.

**Leeds and the Electric Light.**—We understand that the Electric Lighting Committee of the Corporation of Leeds are proceeding as quickly as possible to complete its arrangements for illuminating the whole of the Town Hall Buildings and the Municipal Offices. Electricity was substituted for gas on Tuesday evening in the large rate offices, and it is said that the change was highly acceptable to the officials, as the temperature in which they work was reduced to the extent of four or five degrees. Very little has yet been done in the way of developing such preliminary arrangements as might form a basis for a general electric lighting scheme for the borough.

**Electric Light on the Stage.**—Messrs. A. Schanschieff and Co. write us as follows:—"In the Notes, published in your issue of the 21st inst., we are pleased to find that Mr. Richard Allbright has been successful in lighting at Drury Lane, Crystal Palace, and the Empire Theatre. To complete this statement, allow us to acquaint you that the battteries and lamps he uses are 'Schanschieff's,' and made at our works."

**Electric Lighting at Brighton.**—The electric lighting committee has issued an important report, which will be presented at a meeting of the council, on Monday next. A second professional opinion being desired, Mr. Crompton was asked to consider the report of Mr. Shoolbred, the last named gentleman's views were fully coincided with. In Mr. Crompton's estimate, the whole of the work necessary for the lighting of Brighton will not exceed the sum of £30,000. We hope to give further particulars as to figures in our next issue.

**Ship Lighting.**—The tug-boat *International*, the largest vessel of its kind in the world, owned by a Philadelphia firm, is equipped with electric lighting apparatus.

**A Suggestion for the Compensating of Voltmeters for Temperature.**—We have received the following communication from Mr. C. J. Robertson, A.I.E.E, Holland, which came too late for our correspondence columns :—"Having worked with voltmeters almost daily, for the past 10 years, in testing and experimenting with glow lamps, I have constantly felt the inconveniences arising from changes of temperature in the neighbourhood of the voltmeter, and also in the instrument itself. This has, for a long time past, led me to think that some simple adaptation of the old 'Gatehouse' method (of regulating the temperature of platinum lamps) could be adopted for this end; but I have had neither time nor opportunity to thoroughly try the same. The voltmeter could be wound with just a sufficient number of turns of copper, &c., wire, to obtain the necessary pull, and the rest of the circuit should include a carbon filament, &c., enclosed in a vacuum, and placed as near as possible to the metallic portion of the circuit. Such a carbon could be easily made of any required length or section, and could be further strengthened by treatment in hydrocarbons. The proportions between the length of the metallic and the carbon portions of the circuit could be respectively arranged so that the effects of increase or decrease of temperature in the metallic part of the circuit could be just balanced by the opposite effect in the carbon portion. This carbon could be made in the same manner as for a glow lamp, and of a resistance and length suitable to any voltmeter, wattmeter, &c.; and again by using or leaving out the flashing process, its specific resistance could be adjusted to meet all requirements of space, diameter, strength, &c. Such a carbon compensator should be sealed into a well-exhausted tube (to prevent effects of convection and conduction) and should be embedded in the windings or placed very near to them, and the whole would then supply a long felt want, *i.e.*, a voltmeter compensated for external and internal temperature variations." We may remark that the suggestion is not a new one.

**The Electric Mutual Assurance Company.**—This is a new company in America for providing insurances against loss by fire of material in central and private electric lighting stations. When the enormous amount of capital invested in the electric lighting industry in America, and the unsatisfactory attitude of the ordinary insurance companies are taken into consideration, the need for something of the kind becomes apparent.

**Personal.**—Mr. R. Lewis Cousens is, we understand, to be the representative in South Africa of Messrs. Woodhouse and Rawson United, Limited, and is now on his way to Johannesburg to commence works.

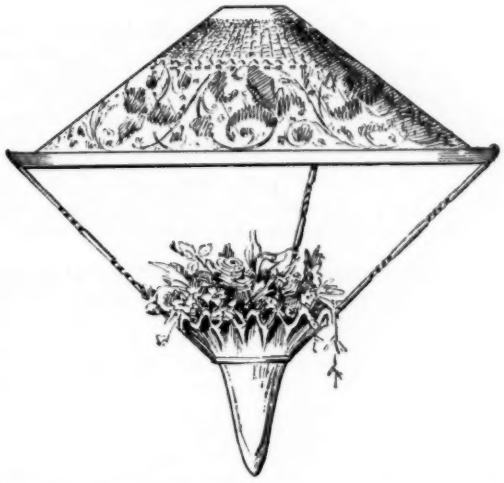
Mr. Frederick Bathurst sails by ss. *Brittanic* for America on the 5th prox. for the purpose of visiting the various electrical works.

**National Electric Light Association.**—On the occasion of the meetings now being held in Kansas City, M.O., the *Electrical World* publishes a bulletin giving in brief notes the proceedings of the day.

**Utilising Broken Lamps.**—Owing to the recent large advance in the price of platinum in the States the electric light companies are paying more attention to their broken lamps and old stems; and the metal derived from this source has an appreciable effect upon the market.

**Electrical Education, U.S.A.**—The new buildings for the electrical engineering course at Princetown, N.J., U.S.A., are almost completed as regards equipment, &c. In order that the iron portions of the other buildings may not affect the delicate instruments in the observatory, this building occupies an isolated position in the grounds.

**Combination Fitting.**—The illustration shows a new combination for pendants (though the same idea has been for some time employed in the case of brackets) which has been brought out by the proprietors of the Electrical Plant Stores, 39, Queen Street, London, E.C., the special name of "E.P. Combination Fitting" being given to it. An ordinary opal or flint glass conical shade (etched or decorated in a variety of designs) is provided with a slightly turned-up rim, from which



are hung three arms and a ring of brass (or other metal) to carry a small glass flower or bouquet holder. Each of the arms is also provided at the top with a hook pointing outwards (not shown in the sketch), on these hooks is placed a plain wire ring threaded through lace or silk fringe. This fitting presents a very neat appearance when complete; and as it can be turned out at a moderate cost, it should prove serviceable for many purposes.

**Electricity in Dentistry.**—A M. Vernette claims to have discovered the secret of painless dentistry without the use of ordinary anæsthetics and the accompanying danger. His method consists in applying the end of a metallic wire in communication with a battery to the nerve, the effect of which is to produce a momentary anæsthesia, when the tooth is extracted. If the statement seems doubtful try the effect for yourselves; we did this once, many years ago, and have no desire to repeat the experiment.

**The Institution of Electrical Engineers.**—The students of the Institution met last Friday at the Sanctuary, Mr. W. M. Mordey in the chair. A discussion was held on Mr. Swinburne's paper on the "Theory of Armature Reactions in Dynamos and Motors," in which the chairman, Messrs. Barton, Walker, Horn, Muir, Childs and Müller took part. A vote of thanks to the chairman terminated the proceedings. At the next students' meeting, to be held March 7th, Mr. H. Walker will read a paper on "Ship Lighting."

**Westminster Supply Corporation's Engineer.**—With reference to recent paragraphs that have appeared as to the appointment of Mr. Gordon, as engineer to this company, we are given to understand that Mr. Gordon has only received the ordinary retainer, and that the chief executive engineer is Professor Kennedy, F.R.S.

**American Humour.**—"We have men here," says a Cincinnati paper, "who would not believe in the telephone until they were called up and dunned for an old debt over the wire."

**The Elmore Copper Company.**—The factories of the company have now been at work for some weeks, and an exhibition of articles recently manufactured will be held early next month. The company is said to have orders in hand to keep the whole of its plant employed for the next two years.

**Order for Fire Alarms.**—Messrs. W. Blenheim and Co. have received an order to fix their improved system of street fire alarm telegraphs for the district of the Local Board of South Hornsey, also to rewire their telephone exchange and electric bell system at the St. Saviour's Union, Dulwich.

**"Engineering" and the Forth Bridge.**—We have received from our contemporary, *Engineering*, advance proofs of the notices of the engineers and contractors of the Forth Bridge. We can congratulate the proprietors on the excellent portraits and on their enterprise, the subject being at present one of great interest.

**Electricity and London Fire Alarms.**—For a charge of £5 per annum a person may be put into electric communication with the nearest fire engine station.

**A New Insulating Staple.**—A New York electrician has devised a new staple which, in some respects, is said to be an improvement. It consists of the usual metal staple, but having attached a saddle of insulated material. The staple being driven into the wall the wire is held in its place by the comparatively large surface of the material, in this way it is intended to prevent the metal coming in contact with the wire. It may be of use in some cases where stapling is permissible, but we think the old metal strap with insulation inside and packed at each end, is better.

**Proposed Electric Tramway at Penzance.**—A bill is now being promoted in Parliament with the view of obtaining powers for the erection of tramways and promenade pier at Penzance. At a public meeting which was held on Friday evening of last week to consider the question, the mayor said that it was now proposed to use electric power for tramways instead of steam power, as was at first intended. Eventually a resolution was passed expressing approval of the proposed bill in principle, but giving the corporation power to watch the measure through Parliament.

**American Telegraphs.**—A Bill for regulating the telegraphs on the "interstate commerce" plan is again before Congress. It is proposed, as in former Bills, to place the telegraphs under the supervision of an Interstate Commission. An electrical contemporary, N.Y., thinks there is much to be urged both for and against the scheme; but that it is decidedly preferable to any Government control of telegraphs.

**Courting Investigation.**—The *Electrical World*, N.Y., is glad to see that Mr. A. J. De Camp, of Philadelphia, "one of the most public-spirited men in the electric light field," has circulated a petition asking Congress to appropriate 50,000 dollars for the purpose of investigating the electric lighting industry, especially with the object of enquiring into the casualties that have resulted from the use of electric currents, and comparing the casualties with those from other lighting agencies.

**Electric Tramways in the States.**—So great has been the success of the electric railway in Minneapolis, even in the midst of heavy snows, that the street railway companies there have abandoned the idea of cable railroads, in spite of the large pecuniary sacrifice incurred by breaking off contracts, and have determined to adopt the electric system of the Thomson-Houston system instead.

**Electric Light in Cuba.**—A Philadelphian firm is supplying two separate electric light plants of 300 16-C.P. incandescent lights each, to a wealthy sugar planter in the interior of Cuba.

**Telegraph Engineering Inspectors' Grievances.**—In the House of Commons, Mr. W. H. Smith, replying to Mr. Baumann, said he hoped shortly to be able to communicate to the House the decision of the Treasury on the Postmaster-General's scheme for improving the position of telegraph engineering inspectors.

**Useful Gifts.**—The Glasgow and West of Scotland Technical College has just been presented with the nucleus of a good consulting library, including some handsome volumes from Sir John Pender, and a bookcase with about forty volumes on electrical engineering from Mr. George Hamilton, of Glasgow. And yet unkind people say that Sir John is unmindful of everything but his own interests. Surely he was not thinking of these when making his offering to Prof. Jamieson's college?

**Electricity in the Cuisine.**—*Le Petit Journal* reminds its readers that experiments with electricity for culinary purposes, similar to those now being carried on in New York, were attempted at the Champs Elysées during the late Exhibition. Our contemporary is willing to admit the rapidity with which the roasting operations were performed, but confesses to a preference for the methods employed by the successors of Carême and Brillat Savarin over those of Arago and Ampère.

**Glasgow Overhead Wires.**—Major Cardew, R.E., adviser to the Board of Trade, reports, as regards the overhead electric lighting wires in Glasgow, that while the insulated wire used is well up to the standard, the earth connections to poles are not made in the way contemplated by the regulations, being simply connected to the system of rain-water gutters and down pipes. He suggests, as a better protection from lightning, that a strand of wires be led down inside a fall-pipe, making a good earth at the bottom, so as to cut out the resistance by the joints of the pipe. The installation is one of the best he has seen.

**Electricity in Ships.**—An attempt has lately been made in the U.S. Navy to light the binnacles of ships by electricity instead of oil; but it was found that by bringing an incandescent lamp close to the compass a deflection of the needles could be produced.

**Society of Arts.**—The arrangements for the week ending March 8th, 1890, are as follows:—On Monday, March 3rd, at 8 p.m., Cantor lectures, "Stereotyping," by Thomas Bolas, F.C.S. Lecture III.—Various Stereotype Methods.—Casting in plaster moulds. Survival of the method for casting from music type. The copper electrotype backed with soft metal. Casts in brass and the more refractory metals. Softer stereotpyes—Celluloid, India-rubber, gelatinous compositions; Wednesday, March 5th, at 8 p.m., thirteenth ordinary meeting, at which a paper will be contributed on "Recent Progress in British Watch and Clockmaking," by Julian Tripplin; William Henry M. Christie, M.A., F.R.S., P.R.A.S. Astronomer-Royal, will preside; and Saturday, March 8th, at 3 p.m., popular lectures on "The Atmosphere," by Prof. Vivian Lewes.

**A Benevolent Project.**—A member of the Virginia Senate has introduced a Bill which provides that, after April 1st, 1890, nowhere within the confines of the State shall there be any electric circuit, "or any substance or thing for the conducting of electricity," in which the electric pressure used shall exceed the following: The non-pulsating continuous current, 800 volts; the pulsating continuous current, 550 volts; the alternating current, 200 volts; and that all telephonic and other circuits other than for the electric light, heat, and power, shall be equipped with safety devices to prevent fires. As the enactment of the measure would close a number of arc lighting stations, including one in Alexandria, which is the property of the City Corporation, the question has given rise to a good deal of excitement. The date chosen shows that "Ole Virginny" still keeps up a flue sense of the humourous.

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**"As Others See Them."**—The *Electrical Review* of New York finds the third and latest annual report of the New York Board of Electrical Control neither instructive nor amusing. It contains, according to the *Review*, a lamentable confession of failure on the part of the commissioners to do the work for which their commission was created—*i.e.*, to put the wires underground. "They tied themselves up to a company with a small capital, who did not do the necessary work, and they did not feel inclined to force them to carry out their contract." The next portion of the report the *Review* finds so far interesting, in that it clearly manifests the board's inefficiency; while the balance is given up to reports of the engineer and the electrical expert, both reports being, in the opinion of our contemporary, "remarkable for what they don't say." The *Review* calls for a new board made up of "properly educated electricians."

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Taunton Electric Lighting Company, Limited.**—The annual return of this company, made up to the 17th inst., was filed on the 21st inst. The nominal capital is £20,000 in £5 shares. The number of shares taken up is 2,230, and upon 1,540 the full amount has been called, and upon 26 shares there has been a call of £3 per share; the remaining 664 shares being considered fully paid. The calls paid amount to £7,718, and unpaid to £60.

**Eclipse Electric Lighting Syndicate, Limited.**—An agreement of 12th inst. cites, that since the formation of the company, Mr. Willoughby Hamilton Power, of 20, Versailles Road, Anerley, has obtained for the company certain cash advances amounting in all to a large sum of money. In consideration thereof the syndicate will pay Mr. Power a commission amounting to £400 which he has agreed to accept in fully paid shares of the company.

An agreement of 12th inst., filed on the 14th inst., cites that Mr. Barnard John Dicksee, of 11, Poultry, has advanced £20, and has rendered certain valuable services to the syndicate, in consideration of which the company will pay a bonus of £20 in fully paid shares to Mr. Dicksee.

An agreement of 18th inst. cites that, by the articles of association the qualification of a director shall be 200 shares. Some time since the directors, being anxious to secure the services of Mr. Robert Samuel Bathe, of 7, Lower Terrace, Notting Hill, to join the board, he consented to do so upon having 200 shares allotted and issued to him at 50 per cent. discount; such shares are accordingly allotted.

**Kensington and Knightsbridge Electric Lighting Company, Limited.**—The annual return of this company, made up to the 17th inst., was filed on the 21st inst. The nominal capital is £250,000 in £5 shares; 15,000 shares are taken up, and of these 5,044 are considered as fully paid. Upon 9,956 shares the full amount has been called, the calls paid amounting to £49,780.

**Automatic Electric Supply Company, Limited.**—The annual return of this company, made up to the 17th inst., was filed on the same day; 15,507 shares are taken up, 15,500 of which are credited as fully paid up. Upon the remaining 7 the full amount has been called and paid, the paid up capital thus being £7. Registered office, Suffolk House, Laurence Pountney Hill.

**Keswick Electric Light Company, Limited.**—The annual return of this company, made up to the 17th inst., was filed on the same day. The nominal capital is £5,000 in £1 shares; 2,265 shares have been taken up, and the full amount has been called and paid thereon.

**Electric Arms and Ammunition Company, Limited.**—The statutory return of this company, made up to the 17th inst., was filed on the same day. The nominal capital is £40,000 in £100 shares. 287 shares have been taken up, and £30 per share has been called up on 77 shares, the remaining 210 shares being credited as fully paid up. The calls paid amount to £2,310. Registered office, 6, York Buildings, Adelphi.

**Syndicate of Electrical Engineers, Limited.**—An agreement of 30th December, filed on the 17th inst., provides for the payment of the preliminary expenses of the company by Mr. Robt. Hammond, in consideration of the allotment of 100 fully paid founders' shares, which will be entitled to the whole of the surplus profits remaining after payment of a non-cumulative dividend of 10 per cent. on the ordinary shares.

At an extraordinary general meeting of the shareholders, held at 117, Bishopsgate Street Within, on the 9th ult., revised articles of association were submitted and adopted, and at a meeting held on the 24th ult., the resolution adopting such articles was confirmed, and was duly registered on the 18th inst.

## ELECTRICAL LITIGATION IN BELGIUM.

A TRIAL fruitful in curious revelations has been recently heard by the Belgian Courts. It was directed against M. Beeckman, a Deputy for Louvain, and one of the founders of the Société Industrielle d'Electricité, of which in time he rapidly became president of the managing council and then managing director. M. Beeckman's management was at first a great success. He obtained the electric lighting of the Northern railway station and the supplying of the dynamos, projectors, and lamps necessary for this installation for his company. The company has now met with reverses, which it imputes to M. Beeckman, and instituted proceedings against him on charges which may be given briefly as follows:—The balance sheet for 1889 presented by M. Beeckman showed a loss of 118,441 francs. In 1888 the balance sheet showed a profit of 15,869 francs. This having been audited, it was found in the first place that this sum should be reduced to 7,799 francs. The company further alleged—and expressed it formally in its pleading—that the balance sheets for 1888 and 1889 were fraudulent, and that the difference between the profits of two years ago and the enormous loss of last year could only be explained by the intention to hide a whole series of anterior deficits. The company also complained that M. Beeckman tolerated a system of book-keeping which experts regarded as deplorable. These experts discovered omissions and commissions in the books which the pleadings qualified as extremely grave, and in favour of which the balance sheets had been drawn up with a view of presenting a fictitious situation. The other charges against M. Beeckman are numerous. He accorded himself, on his own authority, a salary of 7,000 francs, while he was only entitled to one of 5,000 francs. He had shown want of foresight, negligence, and carelessness in his management, which had caused the company a loss of 10,000 francs and compromised the payment of an important debt. An accountant placed under his supervision was answerable for a deficit of 5,000 francs. The workmen's wages had been suddenly and without cause raised to 40,000 francs. The last allegations of the company were the gravest. M. Beeckman had on different occasions told the council of management of important and profitable business with the Belgian and Russian Governments. This business was the supply of dynamos and projectors for the forts on the Meuse, and a similar supply for Russia. In connection with the latter contract, M. Beeckman

caused a sum of 7,000 francs to be paid to himself for a journey to St. Petersburg. The operation with Russia was to be done on account of three parties—the company, M. Lucien Nothomb, and the Bouckaert firm; that with Belgium on account of two—the company and the Bouckaert firm. When the company asked M. Beeckman how the negotiations stood, he refused to say, putting forward the pretension to attribute to himself the profits, even going so far as to inform the company that, if it wished to participate in the profits, it must enter into negotiations with him. This raised the company's ire, and it called upon M. Beeckman to pay the sum of 118,441 francs, the amount of the loss it had suffered, the responsibility for which it attributed to its manager, charging him with "having betrayed the interests of his employers." It also claimed 100,000 francs damages and several other sums in reimbursement of sums improperly collected.

M. Beeckman's counsel, Maîtres Roussel and Picard, deny the facts as stated in the introductory pleadings, and allege that M. Beeckman constantly acted in accord with his colleagues on the council of management, that he did nothing without authority, and that he was not responsible for the losses which the company complained of.

Maître Wauvermans, for the company, opened his case, and the further hearing was adjourned.

## CITY NOTES, REPORTS, MEETINGS, &c.

### Telegraph Construction and Maintenance Company, Limited.

THE report of the directors, to be submitted to the members at the 26th ordinary meeting to be held on Tuesday, the 4th day of March, 1890, at one o'clock precisely, reads as follows:—

The directors feel that their first duty at this meeting is to express their deep regret at the loss the company has sustained in the death of their late chairman, Sir Daniel Gooch, Bart., which feeling they do not doubt will be shared by the proprietors generally, and they desire to lay before them the copy of a resolution which was passed at the board meeting of the 23rd October, 1889, being the first held after that melancholy event.

"Resolved:—That on the death of their chairman, Sir Daniel Gooch, which occurred on the 15th instant, the board of directors desire to place upon record their high sense of the services rendered by him to the company during a period extending over 25 years, for 21 of which he was the chairman, and at the same time to give expression to their own feelings of sincere regret at the loss of an able and upright colleague, for whom they always entertained the highest respect and esteem."

At the same meeting Sir George Elliot, Bart., who has been a member of the board since the formation of the company, was unanimously requested to accept the position of its chairman, and was duly elected.

Mr. James Pender has been elected a director of the company to fill the vacancy caused by the death of Sir Daniel Gooch.

The accounts for the year show a net profit of £83,746 12s. 11d., after charging the interest on the debentures. To this sum must be added £43,376 14s. 4d. brought forward from last year, making a total of £127,123 7s. 3d. From this amount is deducted the interim dividend of 5 per cent., paid July 16th, 1889, amounting to £22,410, leaving £104,713 7s. 3d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income tax, leaving £37,483 7s. 3d. to be carried forward to the next account.

During the past year, the cable factories at East Greenwich and at Wharf Road have been fairly occupied, and the increase in the general business at the latter works shows a marked improvement; a length of about 4,800 miles of telegraph wire has been insulated for submarine cables and land lines.

The company's steamships have laid cables between the Cape of Good Hope and the Port of Mossamedes, on the western coast of Africa, thus completing the circuit of that continent; between Java and Western Australia, thus triplicating the Eastern Extension Telegraph Company's lines to Australia; and between Monte Video and Chuy River, on the coast of Uruguay, for the Western and Brazilian Telegraph Company.

Various repairs have also been carried out during the year, on and near the banks of Newfoundland for the Direct United States, and the Anglo-American Telegraph Companies.

The charter of the ss. *Calabria* continued throughout the year, but has since terminated.

The company's factories at East Greenwich and at Wharf Road are in efficient working order.

The retiring directors are Sir Thomas Fairbairn, Bart., and Mr. James Pender, who, being eligible, offer themselves for re-election.

The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (Messrs. Gane, Jackson & Jefferys), who retires, offers himself for re-election. Mr. James Glegg (Messrs. Welton, Jones & Co.), does not seek re-election. Mr. Patrick Glegg, a member of the same firm, who has always assisted Mr. James Glegg in his audit of the company's accounts, will offer himself to the shareholders for election.

### Notting Hill Electric Lighting Company.

A GENERAL meeting of the Notting Hill Electric Lighting Company, Limited, took place on Monday at the offices, 9, Austin Friars, E.C. Mr. William Crookes, F.R.S. (the chairman), presided, and explained that the result of the recent application to the public had been a subscription of about £70,000, which was sufficient to comply with the terms of the Act. This had enabled the board to apply for a special settlement and quotation on the Stock Exchange. Experience had shown that between 30 and 35 houses paid the expenses of working, while the first 200 houses brought in a profit of £3,000 a year, and the first 400 houses £7,000 a year profit. Their own company had more than 4,000 houses in the district, and the board therefore looked forward to a most successful future for the concern. At a special meeting which followed a formal alteration was made in the articles by desire of the Secretary of the Stock Exchange.

### The Northern Electric Wire and Cable Manufacturing Company, Limited.

THE first annual meeting of this company was held at the company's offices, Square Road, Halifax, on the 18th inst. The directors report a rapidly increasing business, and congratulate the shareholders on the good prospects before the company. After stating that the profits are over 10 per cent. for the year, the directors recommend a dividend of 7½ per cent., placing the balance to a reserve fund, which was agreed to, and after the usual vote of thanks the meeting closed.

### TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending February 21st, 1890, amounted to £4,637.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 21st, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,526.

## LEGAL.

**Chatenay v. Brazilian Submarine Telegraph Company.**—This case came before Justices Denman and Vaughan Williams, in the Divisional Court of the Queen's Bench Division of the High Court of Justice on Friday last, by way of an application by the plaintiff to vary an order made by Baron Pollock in chambers.

Mr. H. D. GREENE, who, with Mr. Alexander Young, appeared for the plaintiff, said the issue to be tried had been directed by the court under the following circumstances. Mr. Chatenay, who resided in Brazil, was on the register of shareholders of the defendant company, and, finding that his name had been removed therefrom, he applied under Section 25 of the Companies Act, 1862, to have it restored, because he contended that his name had been removed without lawful or just cause. Thereupon the court ordered that an issue should be tried, whether the plaintiff's name had or had not been improperly removed, and this issue was now waiting trial before a jury. The defendant company, in answer to the plaintiff's complaint as to having taken his name off the list of shareholders, said that he (the plaintiff) having given a power of attorney to a gentleman in London, they (the company), acting on that power, had transferred the shares out of the plaintiff's name. The defendants contended that Brazilian law, and not English law, would govern the construction of the power of attorney, and, that being so, it gave a general power to the holder to act in the way he had done. Mr. Chatenay, on the other hand, said the power of attorney must be read according to the law of England, and, so reading it, it was clearly a limited power, and did not authorise what had been done. In August last the defendants applied to the Master for a commission to go out to Brazil to examine witnesses as to how the authority would be determined by the Brazilian courts. The Master refused this application, holding that it was entirely a matter for the English courts. Thereupon the defendants appealed to Baron Pollock, who referred the matter for the decision of the judge at the trial of the issue.

Mr. FINLAY, Q.C. (with him Mr. W. Graham), represented the defendants. He said if all that the plaintiff wanted was to have the question of whether the Brazilian law or the English law governed the matter tried as a preliminary question before a judge without a jury, he should not object.

Mr. GREENE acquiescing in this, their lordships ordered the question to be tried before a judge.

**Re James Fyfe.**—On Monday, in the Court of Bankruptcy, the matter of James Fyfe came on for hearing. The debtor, described as of St. Stephen's Chambers, Telegraph Street, City, states that for the past 10 years he has been an electrician, and that for two years to May, 1884, he acted as managing director to an electric light company, in which he had a large interest. He attributes his insolvency to his inability to realise certain property without resorting to litigation, which he considers would be necessary to establish his claims. The receiving order was made in December last, and a statement of affairs has now been furnished, showing gross liabilities £18,707, of which

£17,608 are fully secured, and assets of uncertain value. The securities held by creditors treated as fully secured are stated to consist of shares in electric light companies (estimated at £4,336), and patents for electric lighting (£14,000). The bankrupt considers that a surplus of £927 might be realised on some of the shares.

## THE OPERATION OF ELECTRIC MOTORS WITH HIGH TENSION CURRENTS.

AT the conclusion of Elmer A. Sperry's paper before the Chicago Electric Club, on "The Operation of Electric Motors with High Tension Currents," which was published in the last number of the ELECTRICAL REVIEW, the following discussion took place:—

Mr. DAGENHARDT: I would like to ask Mr. Sperry if, in referring to the breaking down of that insulation on the armature under strain, he meant the exterior circuit or winding of the armature.

Mr. SPERRY: No; I merely mentioned that the strain in the constant potential system was constant, and always existed. The strain on the insulation, of course, exists throughout the line, no matter whether the line be a part of the exterior or interior circuit. The strain on the line in the case of the constant current of course varies according to the amount of energy transmitted. The strain I had reference to is on the exterior circuit.

Mr. DOW: I have made memoranda of two or three points that I would like to enquire about: First, the difference between the brush point in the commutator and that of the greatest difference of potential. That has been referred to by Prof. Silvanus P. Thompson, but it has not been worked out and explained as Mr. Sperry has done. Prof. Thompson finds the non-sparking position to be not the position of the highest potential, but a point so far in front that a slight reversed current is generated in the coil coming under the brush. As regards the rotation of brushes, there has been a motor running in Chicago for about 18 months, and it has worked as well as motors generally. The commutator rotates; it is rotated by a centrifugal governor, and there are a great many others in other parts of the country. It is easier to rotate, having only eight connections to take care of, and the brushes being rather heavy. As regards compound machines, a compound wound generator of 125 horse-power was referred to, and a paper concerning it was read at the last Niagara Convention. The characteristic of the machine was very good; as good as that of any compound constant potential machine that I ever saw; the highest potential was about 1,500 volts. The compound winding part of the machine makes the least trouble. The machine is in use to some extent, and will be in use to a greater extent. So that a problem which as lately as within a year has been announced as impossible of solution, the compounding for a constant current generator of over four or five hundred volts, is actually in process of solution, and probably will be completely solved before another 12 months.

Mr. SPERRY: I am very glad to hear the report of progress, I am sure. The first point the gentleman referred to, however, is not a point I referred to in my paper—the difference in position between the non-sparking points in the commutator and those of the greatest difference of potential thereon. That point does not exist when the armature and fields are so balanced that the non-sparking point is carried around, as explained. The non-sparking point upon the commutator has more particular reference to any machine where the brushes remain stationary, and where the energy is adjusted by leaving the potential constant and adjusting the ampères. Of course the energy is the product of the pressure into the quantity. Now you can work either way. You can leave the pressure equal and adjust the quantity, because when you come down to the zero quantity this quantity multiplied with any amount of pressure would be zero; therefore there would be no power at the zero potential, and zero pressure into the greatest quantity you can attain would also be zero. There would be no power. Take, for instance, the Edison machine, which is as well known as any, or better, probably, there as the load increases the potential or pressure remaining constant, the ampères or quantity vary and come up. This increases the magnetisation of the armature and carries over the point at which the brushes operate best, and are non-sparking. Silvanus Thompson points out that that point is not the point at which the greatest potential can be obtained from the machine. Here we are talking about an entirely different state of facts. We are speaking about rendering a commutator sparkless throughout the entire range, from zero up to its maximum E.M.F. In various works upon the subject this has been pointed out as an impracticability, and people say that it would be a magnificent way to adjust a machine or motor, could it be rendered sparkless. Now, the solution is found by means of a certain mathematical function between the force in the armature and in the field. We find that that thing can be done, and we find not only that, but that the range can be broadened out, as I said in the paper, so that there is quite a little range through which it is perfectly non-sparking; so that if the current at the point at which it ought to be non-sparking varies either side of the point, still it is sparkless and works perfectly. I have been very much interested in what the Brush motor has done. I think this is the one referred to; the commutator is rotated under the brushes. Of course it is perfectly practical from the fact that the commutator sections and coils upon the armature, which have to be coupled with the commutator, are few in number. But in the Gramme armature, or Siemens armature, or any armature, in fact, where there are numerous coils, I think you will agree with me that the current is generated under the most favourable circumstances, inasmuch as in that armature alone is the current perfectly uniform and continuous. Where, however, the coils are only few upon the armature the tendency of the current is to pulsate. Take a medium-sized Brush machine of eight coils. The coils are coupled across, making four coils. Then, as they sweep across the field, one of that four is always eliminated from the circuit. Therefore, there are only three coils which are doing the entire work. A whole third of the working capacity of the machine is taken out at a time, and another third inserted, making a current very pulsatory, which can be very easily determined by holding a bunch of keys near a magnet, charged with such a current, when you can feel a tremour. Where the current is generated under the most favourable circumstances, and a large number of coils are coupled to the commutator, then the trouble comes in attempting the rotation of the commutator, because all those connections have to be flexible to admit of the movement. Then it becomes much more practicable to rotate the brushes, leaving the commutator stationary. However, I wish to say that in the Comstock lode the Brush Company has several dynamos and large motors in operation under its constant current plan with high potential, and the operation is deemed by that company to be very satisfactory and successful in every particular.

Mr. DOW: I wish to say, as I mentioned in the beginning, the reason that the commutator was rotated in the automatic motor is simply the fact that there are only eight connections to take care of. The rotation of the commutator in an automatic motor in stationary work has been in constant use for some years. On street car and similar motors the brushes are rotated by hand to attain the same end. I did not understand that the displacement of the point of best work from that to maximum potential was the exact equivalent of the observation made by Mr. Sperry, and I see that his observation is largely on the displacement of armature polarity. He says also that the displacement he observes is not the displacement commonly known as resultant magnetism between the armature and fields, but is special and peculiar possibly to a machine with double cores. I will have to take that in; I thought the three observations—the resultant magnetism, the displacement of non-sparking out, and Mr. Sperry's observation—were results of the same cause. Now, I must consider them different.

Mr. FERGUSON: Mr. Sperry, in speaking of the comparative complications in constant potential stations and constant current stations, stated that the generators in the constant potential stations were separately excited, as I understood him, and in the constant current stations the generators were self-excited. I think that in the best designed modern stations operated on constant potential, the generators are self-excited, not separately excited. And as far as the complication of the switch-board is concerned, the question of one pressure indicator for every central station, and for every feeder end, does not make a very complicated switch-board. There was another point that I wish to bring out in regard to the self-regulation of a machine. Mr. Sperry stated that constant current machines were self-regulated, whereas constant potential machines were not. Now, there are power stations in this country operated under considerable loss too on the line, in which I have seen the load change from 20 ampères to 160 ampères, without necessitating any change of the brushes, or without altering the E.M.F. on the line. This was on a 500-volt system; and the engineer in charge told me that he had no trouble whatever in operating these machines. They were compound wound, and are being used to-day in one of the largest railroad systems in the country.

Prof. BADT: I have no doubt that in the transmission of electrical energy from one point to another, at long distances, constant current machines might be used very advantageously. But the example that Mr. Sperry selected in which the distance, I think, was three miles, is hardly a fair basis upon which to judge the adaptability of constant potential and constant current motors. If we take, for instance, the transmission of power, as we have it in cities, at longer or shorter distances, and using motors of different sizes (very large and very small motors on the same lines), I think that the constant potential system is preferable to the constant current system, for two reasons. In the first place, if we come down to very small motors, say quarter horse-power, or one-eighth horse-power, we must send the whole through that motor. The current, for instance, may be 20 or 30 ampères, or even more. It must be sent through a very small motor. You would necessarily have to have a comparatively large commutator to carry the current, which would make the motor quite expensive. It would hardly give satisfaction as a constant current motor for another reason, which is safety in handling it. Those little motors, of course, are used for domestic purposes mainly, and it would be objectionable to introduce a very high voltage directly into the houses. Now there is another point. Mr. Sperry showed how the amount of copper increases, and, of course, the cost of copper increases by reducing the E.M.F. Yet, strange to say, it cuts very little figure in the total estimate of cost, at least, that is my practical experience. I have been figuring lately on quite a number of power transmission plants, and I find that even with 500 volts, a comparatively low voltage, at a distance of four or five miles, the cost of copper is so small an item of the total cost of the plant, that I would not stop to consider it. Now you take a plant, for instance, for the transmission of 200 or 300 or 400

horse-power, the difference of cost of the copper, say between 2,000 volt system, and a 5,000 volt system, would not be sufficient to induce anybody to select one or the other plant. I say it seems very strange at first, and it seemed very strange to me; but after figuring quite a number of examples, I found it to be the case that the cost or expenditure in power transmission plants is in the power itself, whatever it may be, a steam engine, water power and so on, and generators and motors. The line itself is a very small item of the total expense. There is another application of the transmission of power in electric street railways, where the constant potential system is far superior to the constant current system. I know of no electric railway in operation in the United States that is operated by the constant current system. I may be mistaken, but I don't know of any.

Mr. DOW: There is one. It is an exceptional one.

Prof. BADT: There are certainly a good many railways in operation in the United States, and so far as I know they all operate on the constant potential system for obvious reasons. The main reason is that it would be, in my opinion, quite a hard thing to transmit power to the cars on a series system. And in the second place, if you employ a series system, you must have overhead lines for both outgoing and returning circuits, as it would be objectionable to have high potential returned by the rail.

Mr. SPERRY: You couldn't do it by the rail and have more than one car on the line.

Prof. BADT: Even if you could, it would not be advisable. So I think, after all, that the application on a large scale, for great power transmission plants, the constant potential will hold its sway for a long time yet. The two main reasons are, safety in low potential, and I think that constant potential plants for transmission of power can be operated easier than constant current plant.

Mr. SPERRY: I do not wish to prolong this discussion, but I am very much interested in constant current machines. Mr. Ferguson said he understood me to say that in a constant potential dynamo an exciter was necessary; that is exactly what I said. With a constant current dynamo of 3,000 volts or 1,500 volts, or 1,000 volts even, undoubtedly an exciter is cheaper than winding the field with extremely small wire. You understand you have to have wire extremely small when you get up to as high potentials as those named. For instance, in the transmission that I have referred to, you have to have 5,000 ohms in the field, and you must have a No. 22 wire.

Prof. BADT: I have seen machines of the United States company of 3,200 volts, and they used very fine wire, a good many miles on the field, but, I think, not as fine as that.

Mr. SPERRY: In this case there were 62 miles of wire on the field. As I said, one reason why an exciter is preferable when you get up to high voltages, is that the wire is so extremely fine and hard to handle that it would be liable to get out of order. In the case of the high potential again, the ratio of cotton to copper or the ratio of insulation to copper is great—this requires an immense space. You have to have a large machine as compared with the series machine. It costs more for copper; it costs more for iron; it costs more to build a machine, because it has to be a larger machine. The ground I took with regard to the exciter was not that the 220-volt machines that you have here, or 110-volt machines would necessitate the use of the exciter; it is merely because with the high potential, in the case I cited here in the paper, an exciter would be far preferable in rough and inexperienced hands, or in trying to maintain it at no very considerable cost. In regard to the switchboard, take the ordinary high potential machine, constant current, the dynamo is located in the station, and the wires are worked from the two binding posts of the dynamo, one to a small ammeter on the wall, and both out of the station; no switchboards, no rheostat for the control of the fields, as in the case of an ordinary shunt-wound dynamo, or even in the case of a compound or over-compounded machine, as they are now made. We have to have an adjustment even on that; and as I say, the switchboard arrangements are similar. But with constant current there is no switchboard necessary. The wires merely go from the dynamo out on to the main line to the motor, or whatever translating device may be used. Whereas in the constant potential there must be a rheostat, and there should be also an ammeter, and the high potential voltmeter is a very expensive item, because it must be made to withstand the extreme potential, of course. With regard to the point that Prof. Badt brings forward, that with a constant current small motors cannot be operated—he meant that it was impracticable, perhaps—there are many in place to-day, quarter horse-power, in operation very satisfactorily with 10 ampères.

Prof. BADT: If you transmit a couple hundred horse-power you will have more than 10 ampères in your line.

Mr. SPERRY: I have taken here the transmission of power from one point to another; I have covered that point in my paper by saying that undoubtedly for widespread distribution a constant potential system is more practical at the present time, but in the near future I see no reason why it should not give place to the constant current.

Prof. BADT: If you want to transmit say 200 horse-power?

Mr. SPERRY: Yes.

Prof. BADT: In such a case it is almost impossible to employ little motors. I do not speak of arc light circuits, but of transmitting a couple of hundred horse-power, where the power is distributed all along the line. That I say is impossible.

Mr. SPERRY: I do not look upon it as impossible.

Prof. BADT: Take a one-eighth horse-power motor, with 60 ampères passing through it?

Mr. SPERRY: I hold that in a distribution of that kind where a constant current will be employed, there should be no motor used as low as one-eighth horse-power.

Prof. BADT: That shows that small motors cannot be used in such transmission.

Mr. SPERRY: In the case of transmitting power from one point to another there is no comparison in the practicability all around, between the constant current and constant potential. I can show you by actual figures as to the cost of the apparatus, as to the cost of the installation of the line, including the construction, as to the cost of the motor, that there is no advantages in the comparison. I do not agree with you that, as compared with the electrical ont-put, or as compared with the money invested in the total plant that the particular portion of the money invested in the line is small, especially at 500 volts named by you. That item is quite large as compared with the amount of money invested in the electrical part of the plant. It makes a great deal of difference whether it is $7,200 or $800.

Prof. BADT: Not if the whole station was to cost $200,000.

Mr. SPERRY: In that case the same ratio would hold, but you would be dealing with far larger quantities. I say that in a station costing $200,000 for the transmission of energy from one point to another, the constant current is the only thing that ever ought to be employed for economy; that is the ground I take, and I can maintain it with figures.

Mr. FERGUSON: I would like to say a word about regulation. Mr. Sperry said in the constant potential machine there was something on the back of it that you had to regulate in an over-compounded machine. I think Mr. Sperry will remember that in any constant current machine, if he has a regulator on it, he has to set it when he first starts his machine. In an over-compounded machine if you set it once, it holds good for ever. You don't have to change it at all. There are over-compounded machines running in this country, which require no hand regulation or changing of the brushes under changes of load.

Mr. SPERRY: Allow me to say one thing about over compounded machines; there is one trouble about them. An over-compounded machine is supposed to hold the potential constant, at the ends or at the centre of distribution. Now then, we start and take off various transmitting devices along down the line. That is often done in transmission, especially in mining processes where you distribute, for instance, 80 to 150 horse-power in a mine. You have the mains that go down the shaft and out the main entry, clear to the centre of distribution, and from that point distributing to the main room and main entries where the work is in operation. It is very desirable to have light, and perhaps a motor or two in use as you go down. The trouble with using an over-compound motor is that where it is set for holding the potential constant at the centre of distribution only, the potential is not constant anywhere else. Just the moment you increase your power in ampèrage on the machine, the speed will naturally fall. We have tried both. We have put them under the same conditions, and I fail to see where any particular practical advantage arises from the over compounded machine under those conditions. Of course, it is a beautiful thing in figures. But as it operates practically, it does not seem to have any particular advantage over and above an ordinary shunt machine. And one more word upon that line. I want to say that the ordinary shunt machine, when built with a good high armature velocity, and with the low resistance in the armature, very few turns compared with the electromotive force, that it can be so constructed that it can be made almost perfectly automatic.

For the successful operation of machines it is essential that all complexities should be done away with, when they are to be put out in the hands of the ordinary engineer to be operated. As soon as your machine is set up the letters commence to come in, "What is this for?" "How do you adjust this?" and "How do you adjust that?" All these things should be avoided.

F. L. PERRY: I would like to ask one question in regard to constant potential motors, which was suggested by Prof. Badt's remarks in regard to the relative advantages of the constant current system and the constant potential system. Isn't there a decided advantage in the constant potential motor on account of its ability to handle a load in excess of its rated power? Now, the point I refer to is this; I remember in St. Paul at one time I installed a three-horse arc motor for elevator work, and that motor at times had to take a load in excess of three horse-power. Of course, it failed; yet the company furnished a three horse-power constant potential motor that did the work. Now, the consumer couldn't understand this, and thought it was very peculiar that he couldn't do with a three horse-power constant current motor what could be done with a three horse-power constant potential motor. Of course, the only answer to that question is the three horse-power constant current motor was sometimes overloaded in elevator service, and the other motor was capable at times of furnishing more than three horse-power. Isn't that a point in favour of a constant potential motor?

Mr. SPERRY: I will answer that that is one advantage. It is the *one* advantage that the constant motor has, that you can load it up to almost 50 per cent. over its normal capacity for a short time. Of course, it commences to heat rapidly, and the extra loads must be shortly taken off, or the motor will burn up. But the constant current motor to meet those extra requirements will have to be built larger. Even then with high potential it is not nearly as large a machine as the constant potential motor.

Mr. FERGUSON: From a commercial standpoint it is a well known fact that all the motor companies, if they possibly can, will set up a constant potential motor. Companies selling

both will sell a constant potential motor every time in preference to a constant current motor. It is well known in this city that the companies are taking out the constant current motors and installing constant potential motors.

I would like to say that it seems to me that the question of regulation is simply coming down to a question of wiring. Mr. Sperry speaks of an over-compounded machine keeping the pressure at the centre of distribution the same as at the dynamo. That is just the point. It does. If your wiring system is properly designed, your pressure throughout the entire system will be constant, and the potential in the centre of distribution constant. It is simply a question of wiring, construction and design.

As far as the complexity of the machine is concerned, I do not understand why an over-compounded machine is any more complex than a shunt machine after it is once set by the expert. The expert sets the rheostat on the back of the machine, or wherever it may be, and, after that is once set, you don't have to do anything with the machine at all. It takes care of itself. There is no sparking, and you don't have to move your field resistance at all. The engineer doesn't have to do anything at all to the machine, except to look after the bearings and keep the brushes clean.

Mr. SPERRY: The trouble with the compound machine is that after you put it on the engine, when you load up the engine, the speed comes down. If the engine is regulated by a centrifugal governor of any kind it does not matter how it is worked, so long as it is worked by centrifugal force; as soon as the load increases steam must be let on in some way, which means that the governor balls must come in, and the centripetal force must be allowed to act. That means that there must be a loss of speed somewhere. Now, of course, that loss of speed affects the dynamo, and that means that the dynamo is not run with a constant speed. The moment your load comes up your speed is crippled to a certain extent. Where the method of transmission of power to your dynamo is by means of the belt, when the load is increased the belt will commence to slip. The machine works beautifully in theory and in mathematics; but when you commence to calculate the trouble and to see the practical conditions under which it must operate, you will find, as I have done, that it does not work much better than an ordinary shunt machine; it costs more to make it; it is more complex. It has been said in regard to the central point of distribution, if the wiring is done right, as it ought to be done, the machine will work satisfactorily. Of course you notice that in the instance that I have given here the mains come down the shaft and go along the entries, and have to go out to the central point of distribution, many times a long distance. Now, you would have to start a long wire away out there and bring it back, when you could as well utilise the energy on the main wire. The first thing the mining engineer would say would be, "Why do you take that wire from the distant point and bring it clear back to this point again?" In the ordinary distribution the best way is to use large mains with little drop, and to use them for all purposes as they pull along.

F. L. PERRY: I notice that Mr. Sperry said in his paper that he thought in the future the centrifugal governing machine would be brought to the same state of perfection, so far as governing is concerned, as the shunt-wound or compound-wound motor. It seems to me that the remark he makes about our best steam engine would apply as well to the best constant current motors.

Mr. SPERRY: I spoke of the average engine.

Mr. FERGUSON: I do not think the mechanical engineers would agree with Mr. Sperry in his remarks; any good engine will give a regulation within two per cent., and with that regulation you ought to get a machine that will operate well on constant potential. The question of wiring for mining, it seems to me, is a very extreme case. The mining business is not the only business in which we use the transmission of power by electricity.

There are instances in this country, in Boston especially, to-day, where there are over-compound generators that run at 500 volts, and keep the pressure at 500 volts without changing the brushes at all.

Mr. BLISS: I did not intend to express an opinion as to which is the better current to use for motors, whether the constant potential or constant current, but I am interested in a small electric street railway which is operated under rather aggravating circumstances. For instance, there is a rise in grade of 300 feet in two miles. It is a fact that the person who has charge of the dynamo room says that he gets a great deal less sparking if he stands right by the generator and moves the brushes as the load comes on the dynamo. Now it is still further a fact that I have stood by the voltmeter, and have tried the voltage on the line repeatedly, and sometimes for long periods of time, and found a very decided change in the potential on that wire. Now I suppose to a certain extent that may be due to some slight variation in the engine, as the load comes on the machine, but I don't think that is enough to account for the variation in the voltage on the line.

And furthermore, it is a fact that we have had quite a number of burn-outs in the motors themselves. Now the point that Mr. Sperry raises in regard to two motors worked upon the same car, or connected together, is a very important one in electric street railways at the present time.

Prof. BADT: In a street railway system, if we had a constant current motor, and the car was overloaded, and was trying to climb up a grade, and the motor was capable of developing five horse-power only, the car will not go up. In the case of a constant potential motor the motor will do whatever is necessary, but of course if it has to do more than the work it is built for, very often the armature will burn up. The difficulty with the majority of electric street railways has been that the motors employed were too small. A car, as a general rule, on a level track, can be run with three or four horse-power easily, but the moment it is heavily loaded, and it has to go up a grade or around a sharp curve, it will take ten or twelve or fifteen horse-power for the fraction of a minute, or even for a few minutes. A very simple rule is to make your motors large enough, and then you won't be burning up armatures. In all the railways that I have seen constructed, during the last six or seven months, they have put in motors which were called five horse-power motors, while, in fact, the motor would easily do fifteen horse-power work if required. So I do not think that there is any advantage in the constant current motor over the constant potential motor at all. It simply shows that the constant potential motor will do whatever it is required to do. If it is overloaded, of course, it will heat and burn up. I would rather it would do that than simply to let the car stand in the street on account of a little incline.

Mr. BLISS: I don't want any misunderstanding as to the capacity of the motors on these cars, because they are twelve or fifteen horse-power motors.

Mr. DOW: I want to spring a bunch of heresies and then sit down. The first heresy is, that over-compounded machines, not for power, but particularly for incandescent lighting, have been in use for some time. They don't have any rheostat on the backs, not even a switch sometimes. They are put into the hands of planing-mill engineers and wood-choppers, and the directions are simply to keep them running steadily, and rock the brush backward and forward, so that they don't spark. Those machines work. These over-componnded generators have been a great success; no trouble, no repairs, very little trouble in operating. The second heresy is that series railways are in operation. I thought I heard Prof. Badt say that there was no street railway working under normal conditions of heavy city work. I want to say there is such a railway in operation with a series system, and it is not complicated, and the difficulties arising in connection with it are not such as to be discouraging at all. As far as commercial results are concerned, it is a great success. There are several others in operation, but I will not refer to them at present. I think from what I have seen of street cars operated by the series system, that that system has a great future before it. It can be worked as an automatic block system, so there is no possibility of a collision, and so operated will be specially useful in mine work and work of that kind.

The third heresy is that the question of change of lead, not only in constant potential motors and generators, but in constant current motors and generators is a matter to be got over by proper proportions. There are constant current motors running up to medium size—say 10 to 15 horse-power—that don't spark and don't require an adjustment of the brushes. A constant current compound-wound generator with constant lead is not yet on the market. I don't know when it is going to be put on the market, but it is going to get there, I have no doubt.

Mr. FISH: It has been stated here that a company in Chicago has been taking out constant current motors and putting in constant potential motors. I represent the largest company in this city, and I wish to state that the main reason for that has been that the effort has been made to run these motors with an ordinary lighting generator. That generator is satisfactory as far as the automatic regulation for lamps is concerned, but it is too slow for a motor. At present though, we have a motor generator of the capacity of 80 horse-power, and we can run 100 lights on it, so that I know I am safe in saying that it has 80 horse-power capacity. With that generator in operation, I feel safe in saying that there will be no more constant current motors taken off of that circuit, and constant potential motors substituted.

## THE WYNNE ELECTRIC TRAMWAY SYSTEM.

THE following report on Mr. Wynne's system of applying electricity to the working of urban tramways has just been issued:—

The Brush Electrical Engineering Company, Limited,
112, Belvedere Road, Lambeth,
London, S.E., *February 5th*, 1890.

We have lately had an opportunity of examining a scheme which bids fair to solve the problem of electric traction on tramcars without the use of open conduits or accumulators.

Mr. Frank Wynne, of 5, Westminster Chambers, is the inventor of the new system, in which power is transmitted from the engine to the car as directly as by rope traction, without the objectionable necessity of cutting a continuous slot in the roadway.

Mr. Wynne has been engaged in endeavouring to solve the problem of urban electric tramways for upwards of four years, his efforts have been watched with keen interest by engineers and electricians in England, and the skill and foresight with which he has approached the subject have met with general recognition.

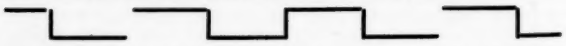
While electricians and tramway companies in this country have been experimenting with accumulators and slotted conduits, tramlines with overhead conductors have been carrying all before them in America, and excellent commercial results have been obtained.

The method of transmitting power to a tramcar by an overhead conductor, though well suited to new and rapidly developing districts, is absolutely inapplicable to English and most Continental cities, and no serious attempt has ever been made to introduce them in this country.

Mr. Wynne's new system secures all the advantages of an overhead conductor system without any of the constructive disadvantages of an open conduit.

Among the chief advantages of the overhead system are that it enables ordinary permanent way to be utilised without reconstruction for heavier weights, and it allows of existing cars being used with some modifications. These advantages hold to the fullest extent in Mr. Wynne's system, the object of which is to enable the electric current to be transmitted direct from the generating station to the car motors through an insulated cable laid underground, after the manner of electric light cables, with absolute safeguards against the possibility of including any of the ordinary traffic of the street in the electric circuit. The current used is that known as the low tension continuous current.

In the centre of the track is laid a crenellated contact plate or rail in short sections, this contact plate or rail is not straight, but is formed to follow the junction line of the sets thus :—

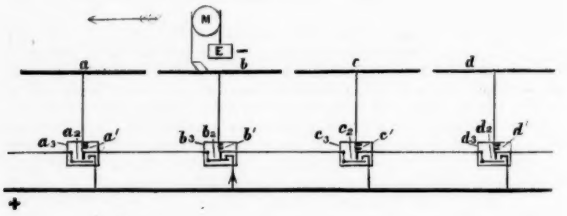


It is half an inch wide on the surface and about 4½ inches deep, it offers no obstruction to carriages crossing the track, snd affords a good foothold for horses.

Mr. Wynne has invented a remarkably simple device whereby the sections of the centre rail are successively put in connection with the main insulated conductor as the car passes over them, and are disconnected again as the car proceeds.

The only sections in connection with the main are those covered by the cars and its platforms; two sections are always in circuit, and a third section may be momentarily so connected as the contact brushes carried by the car pass over one of the separating spaces. The sections are necessarily short, and the inevitable leakage is therefore reduced to quite a negligible quantity.

The device for making contact with the sections of the central rail is shown in the following diagram :—




$a$, $b$, $c$, $d$ are 4 sections of the sectional contact rail, $a^1$, $b^1$, $c^1$, $d^1$ are electro-magnets traversed successively by the current passing from the main conductor + to the car motor M.

$a^2$, $b^2$, $c^2$, $d^2$ are armatures and contact makers actuated severally by the electro-magnets, $a^1$, $b^1$, $c^1$, $d^1$, and are severally contained in the contact boxes $a^3$, $b^3$, $c^3$, $d^3$.

It will be noticed that as the car passes over section $b$, the current passing through the magnetic coil, $b^1$, not only closes the contact in connection with its own magnet, $b^1$, but also puts the magnet, $a^1$, in circuit in parallel with $b^1$.

This arrangement effectually obviates sparking, and provides that one section shall always be charged in advance of the contact brush. The contact pieces assume their original position by gravity, thus disconnecting the sections as the cars leave them.

The contact boxes may be placed in any convenient position, as, for instance, in the footway or curbs, but their construction is such as to render them suitable for fixing in the tramway track. The boxes themselves are of cast iron or steel, with a grooved or "diamond" surface, and are constructed on the diving-bell principle, so that the enclosed air will absolutely debar water from rising into the interior.

It is obvious that it is an essential part of the scheme that the current should never be cut off entirely from the magnets, for under such circumstances they would break contact with the sectional rail, and the car could not proceed. Mr. Wynne has provided thoroughly practical devices both for maintaining the circuit and for remaking it in the event of accidental disturbance, as for instance by reason of the car leaving the rails.

Under ordinary circumstances a small percentage of the current is kept on when the motor has stopped, or when the car may be going down hill.

In the event of contact being accidentally broken, the driver, by moving a lever, brings down a supplementary contact brush which closes the circuit of a single cell battery, and so re-establishes the current through the contact boxes.

There can be no doubt as to the great engineering skill displayed in Mr. Wynne's proposals, the details of which are eminently practical. The contact boxes are numerous, but there is no difficulty in adapting them to work under the conditions of a tramline, and the mere fact of the necessity of their manufacture in large quantities will reduce their cost and tend to simplify their details. This tendency is well illustrated by Lancashire cotton mills, in which 40,000 spindles are often found working all the year round, with scarcely any repairs.

We are much impressed with Mr. Wynne's scheme, and consider that it is the only practical attempt that, up to the present, has been made to grapple with the real difficulties of urban electric traction.

Batteries are ruinous at present prices, overhead conductors inadmissible in English towns, and open conduits are an aggravation of all the evils attendant on the use of straight rails in crowded street. Mr. Wynne's invention has none of these drawbacks. We do not think that his crenellated contact rail would be in any way objectionable in well-laid roads such as are usually found in London and the principal provincial towns.

On the question of capital cost and cost of power, we have carefully examined the accompanying estimates laid before us by Mr. Wynne, after comparing them with data derived from our own experience; and we are of opinion that they are formed on a good commercial basis, a sufficient margin having been allowed for extras which are inevitable in carrying out a new scheme.

The estimate of capital expenditure for applying this system to an existing tramway amounts, as shown, to £2,200 per mile of single track; this leaves out the items of real estate and buildings, which will be much less for a line worked by electricity than for one worked by horses in which the area of ground and the buildings required for stables and granaries are very large.

Against this capital expenditure of £2,200 per mile (including, as it does, boilers, engines and dynamos for twice the maximum power required at any one time), must be set the capital cost of horses and of horse cars, amounting respectively to £1,500 and £500 per mile on the North Metropolitan Tramway, or altogether to a sum nearly equal to that for applying electricity.

The large figure of 7½ electrical horse-power per car has been introduced with these estimates to cover a line with steep gradients, and so make the estimate of safe general application. American experience shows that this is an ample allowance for the not very marked effect of gradients in increasing the aggregate power required.

JOHN RAWORTH, *Superintending Engineer.*
N. SCOTT RUSSELL, M.I.C.E., *Consulting Engineer.*
W. M. MORDEY, *Electrician.*

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### ESTIMATE OF CAPITAL COST.

Tramline four miles in length, double track.
Generating station in centre, two miles from each end.
Average speed, seven miles per hour.
Ten minutes' service.
Cars spaced 2,000 yards apart.
Total cars in action at one time, seven.
Electric horse-power per car, 7½ = 5,600 watts.
Total electric horse-power, 52½ = 40,000 watts.
Voltage at generating station, 250.
Maximum loss, 15 per cent. = under 40 volts.
Ampères per car in middle of line, 20.
" " at ends " 25.

Main conductor tapers in half-mile lengths from generating station to termini.

The lengths and sizes of conductors are as follows :—

| | | | |
|---|---|---|---|
| 2. | ½-mile lengths ... ... ... ... | ·195 | square inches. |
| 2. | " " ... ... ... ... | ·150 | " " |
| 2. | " " ... ... ... ... | ·103 | " " |
| 2. | " " ... ... ... ... | ·053 | " " |

The most suitable cable for the purpose, having regard to the number of joints, will be Callender's bitumen insulated cable, which may be obtained at the following prices :—

| | |
|---|---|
| 1 mile ·195... ... ... ... ... ... ... | £300 |
| 1 " ·150... ... ... ... ... ... ... | 250 |
| 1 " ·103... ... ... ... ... ... ... | 160 |
| 1 " ·053... ... ... ... ... ... ... | 95 |
| 16 Miles of junction wire, at £35 ... ... ... | 560 |
| Roadwork at 2s. 6d. per yard ... ... ... ... | 880 |
| Casing at 2s. 6d. per yard ... ... ... ... | 880 |
| Joiners' work ... ... ... ... ... ... | 500 |
| Contact boxes (every 3 yards), at 15s. ... ... | 3,600 |
| Crenellated rail, 33 tons per mile, at £6 per ton ... | 1,584 |
| Supervision and sundries, at £100 per mile ... ... | 800 |
| Generating station for 120 E.H.P., being double the maximum power required at any one time for working the line, and including a complete duplicate plant of boilers, engines, and dynamos, at £30 per E.H.P. ... ... ... ... .. | 3,600 |
| 11 cars (4 in reserve) complete, with motor and fittings, at £400 ... ... ... ... ... | 4,400 |
| Total ... ... ... | £17,609 |

Say £17,600 for the 8 miles of single track, or £2,200 per mile.

### ESTIMATE OF COST OF POWER PER CAR MILE RUN.

It takes 1 horse-power hour to drive a tramcar one mile (this agrees with the results of extensive working in America).

The cost of this, including coal, oil, waste, water, engineers, firemen, and dynamo men, with depreciation at 7½ per cent. per annum on half the generating plant, amounts to 1½d.

FRANK WYNNE.

*February 1st*, 1890.

# PROCEEDINGS OF SOCIETIES.

## The Institution of Electrical Engineers.

"Some Points in Dynamo and Motor Design." By W. B. Esson, Member, read February 20th, 1890.

Though the recent progress in dynamo construction has been of a highly satisfactory character, there still remain several points affecting design which have received but inadequate attention, and to which reference is seldom made outside the drawing office. In the present paper a few of these unsettled points will be brought before the Institution, in the hope that a full discussion will enable us to make some progress towards a solution of the various questions raised.

### 1. Magnetising Force for a Simple Magnetic Circuit.

Foremost amongst the factors which have contributed to the progress of recent years has been a more perfect comprehension of the laws of magnetic induction, and now, knowing the magnetic properties of the iron with which we deal, it is a perfectly easy matter to determine the magnetising force required to produce in any simple magnetic circuit of given configuration a specified induction. The formula of Drs. J. and E. Hopkinson, which was published in the *Philosophical Transactions* in 1886, is now adopted by most designers who desire to economise their time.

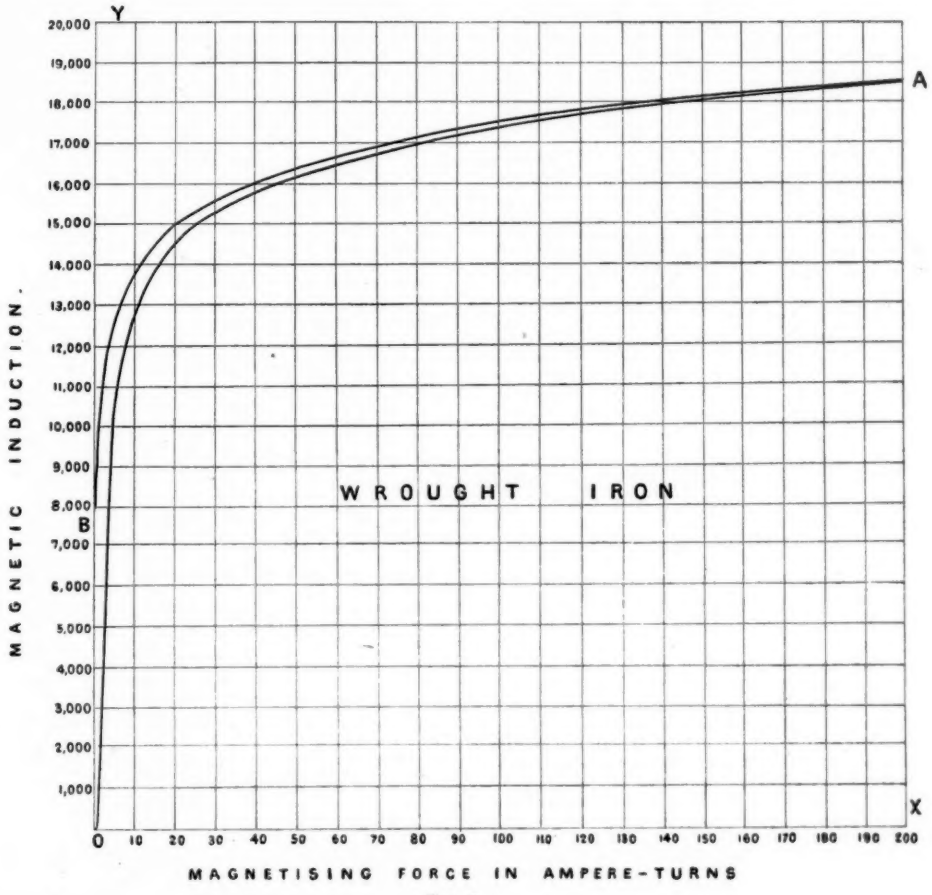


FIG. 1.

Reduced to ampere turns, this formula for the magnetising force is—

$$A_1 = L\,f\left(\frac{N}{a}\right) + L_1 \cdot 8\,\frac{v_1\,N}{a_1} + L_2\,f\left(\frac{v_2\,N}{a_2}\right) + L_3 f\left(\frac{v_2\,N}{a_3}\right) + \ldots.$$

Here $A_1$ is the magnetising force; $L$, $L_1$, $L_2$, and $L_3$ are the mean lengths, in centimetres, of the separate parts which constitute the magnetic circuit—comprising in this case armature core, air gaps, magnet limbs and yoke—while $a$, $a_1$, $a_2$, and $a_3$ are the cross sections, in square centimetres, of these several constituents. Owing to the spreading of the induction, it is necessary to assume the air gaps as having an extension beyond the polar area equal to ·8 of the distance between the armature core and the polar surface. Of the induction produced in the magnet cores, only the portion $N$, which passes through the armature and is enclosed by the coils at the brushes, is serviceable, the lines of force which choose a path outside the armature constituting a stray field which cannot be utilised. In the above expression $v_2$ is the ratio of the induction in the magnets to that in the armature, the total lines induced being therefore $v_2$ $N$. Since in cylinder armatures some of the lines stray through the internal opening, in these the induction in the air gaps will be greater than $N$. If we call $v_1$ the ratio of the lines in the gap to the lines in the armature, the lines in the former will be $v_1$ $N$. the functions $f\left(\frac{N}{a}\right)$, $f\left(\frac{v_2\,N}{a_2}\right)$, &c., are read directly off the curves, figs. 1 and 2, where ordinates give the induction per square centimetre, and abscissæ the corresponding ampère turns required per centimetre length. These curves are reduced from the results of Dr. John Hopkinson.

### 2. Magnitude of the Stray Field.

The expression in 1 gives a general formula for any configuration of magnetic circuit, but in order to employ it, we require to know the values of $v_1$ and $v_2$, or, in other words, we must know the magnitude of the stray field. To be quite accurate, we should know the exact distribution of the field, for in any particular machine $v_2$ has evidently a different value at every part of the cross section. In the absence of actual measurement, however, its mean value can only be guessed at from a knowledge of machines of similar type.

The value of $v_2$ in different types of machines depends not only on the shape of the magnetic system, but on the position of adjacent masses of iron in bed plates, bearing brackets, flywheel, &c. Calculations undertaken with a view to ascertaining its value from a knowledge of the shape of the machine, without reference to previous machines, are necessarily of a laborious character, and the labour in the end leads to no great accuracy. But I find that a very close approximation to the truth may be arrived at by taking the known value for some particular type of machine, and considering step by step the effect produced in the stray field by the changes in the dimensions and shape. It must be remembered that no two machines of the same type have exactly the same value of $v_2$ unless their dimensions correspond in every particular. Every alteration to the patterns, and every modification in the details, introduce a new value for this ratio. Our calculations, therefore, must be to a great extent guesswork. We cannot help it. If the guess is a good one, we congratulate ourselves on the soundness of our judgment, or on the accuracy with which we make our calculations. If it is a bad one, we write to the forge about the annealing of the iron.

The values of $v_2$ have been ascertained for the following machines, and it will be found, probably, that for all modern types they lie between these limits. With these values to guide us we cannot go far astray in new designs.

TABLE I.—STRAY FIELD IN DIFFERENT DYNAMOS.

| Name of machine. | Field. | Armature. | Remarks. | Value of $v_2$. |
|---|---|---|---|---|
| Edison-Hopkinson ... | Single magnet, 2-pole | Drum | Poles next bed plate | 1·32 |
| Siemens ... | Single magnet, 2-pole | Drum | Yoke next bed plate | 1·30 |
| Phœnix..... | Single magnet, 2-pole (fig. 8) | Cylinder | Yoke next bed plate | 1·32 |
| Phœnix..... | Double magnet, 2-pole (fig. 3) | Cylinder | Horizontal | 1·40 |
| Manchester | Double magnet, 2-pole | Cylinder | Bed and one pole cast together | 1·49 |
| Victoria ... | Double magnet, 4-pole | Ring | Ordinary pattern | 1·40 |
| Ferranti ... | Double magnet, multipolar | Coreless disc | Ordinary pattern (alternating) | 2·00 |

The measurements of the Edison-Hopkinson and Manchester machines were made by Drs. J. and E. Hopkinson, of the Victoria by Mr. Mordey, of the Ferranti by Dr. W. E. Sumpner, and of the Phœnix by myself.

When the linear dimensions of a machine are increased in the same proportion, $v_2$ remains approximately unaltered. Suppose, for example, that all the dimensions of a magnetic system are increased $n$ times. If the induction per square centimetre is the same, the total flux of lines is $n^2$. The cross section of all the paths for stray lines are increased to $n^2$, and the distances between adjacent surfaces are increased $n$ times. The lengths and cross sections of the stray paths are therefore increased in the same proportion as the useful paths, and the ratio between useful and useless lines is unchanged.

If, the length of the magnetic circuit remaining the same, both dimensions of the cross section are increased $n$ times, making the area $n^2$, the total flux through the machine is $n^2$; and since the cross sections of the stray paths are $n^2$ times greater, the value of $v_2$ remains as before.

If the length of every part of the magnetic circuit is increased in the same proportion, while the cross section remains the same, $v_2$ is increased somewhat, owing to the increase in the cross section of the stray path. If the dimension of either factor of the cross section is increased, while the other is unchanged, and the length of the magnetic circuit remains the same, $v_2$ is reduced, its reduction depending upon the ratio of the two factors of the cross section.

As the exact value of $v_2$ is a matter of some doubt until the machine is built, it may be instructive just to notice upon what the difference in the calculated flux through the armature, and the actual flux as modified by an error in the estimation of the stray field, depends. Assuming that we can measure accurately the path of the induction in the armature—often a matter of uncertainty—the magnetising force for the armature and the air gap can be determined independently of the magnitude of the stray field. The magnetising force to be allowed for the magnets depends, however, on the amount of stray field we assume. Imagine that in designing the machine we estimated a certain value for $v_2$, which turns out, when the machine is built, to be too low. Now the reduction in the flux through the armature due to this error will depend upon the magnetising force required for the magnets as compared with that required for the rest of the machine, and on the difference in the magnetising forces necessary for the induction in the magnets under the real and assumed values of $v_2$. If these two quantities are large, the error will be considerable, increasing as the magnets are more saturated, and as their resistance in proportion to the other components of the magnetic circuit increases. If the difference in the magnetising forces for the real and assumed values of $v_2$ is small, the converse holds good, the error being small in proportion. In the Edison-Hopkinson machine, for instance, the magnetising force required for the magnets is rather over one-eighth of the whole machine, and the value of $v_2$ is given in the table as 1·32. If in this machine an erroneous value of 1·25 had been estimated in designing, the diminution of the flux through the armature, with the calculated ampere-turns so allowed for, would be only about 2 per cent; *i.e.*, the machine, to give the same output, would have to run at 765 revolutions instead of 750. If the magnets were saturated to a greater degree, or constituted a larger proportion of the magnetic resistance, the error would be correspondingly greater.

It must be noticed that the values in Table I. are given at the working saturation of the machine. As the bending in the magnetisation curve of the iron becomes more pronounced, $v_2$ increases. In actual machines we work above the bend, and with a reduced saturation $v_2$ would be less than given in the table. In practice, differences in the quality of the iron lead to much greater errors than are likely to arise from an error in the estimation of the stray field.

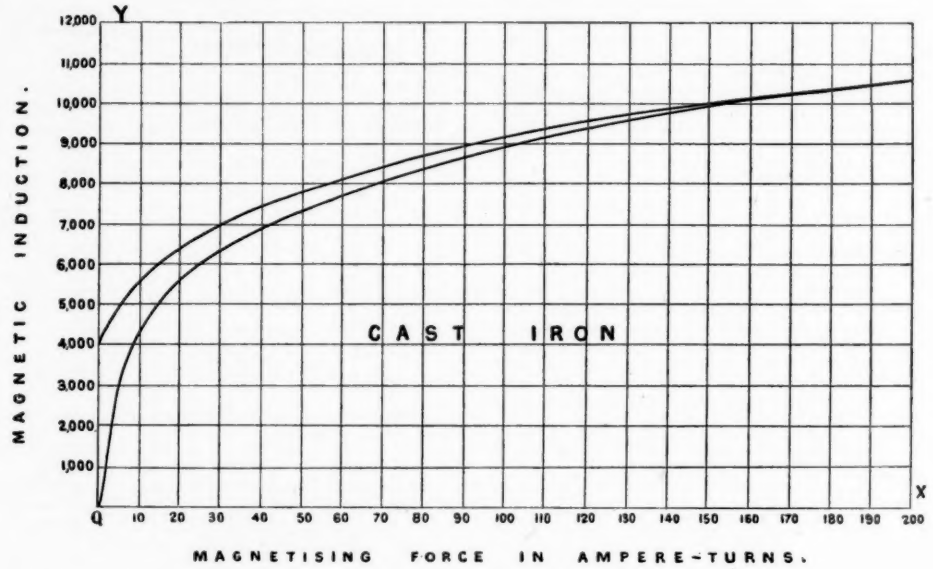


FIG. 2.

### 3. SYMMETRY OF THE FIELD.

It is of some importance to obtain a symmetrical field through the armature, as it is only when the field is symmetrical that the armature is electrically and magnetically balanced. Looking at fig. 3, it will be observed that a line, A B, drawn diametrically

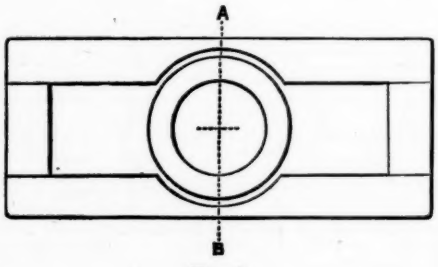


FIG. 3.

across the armature divides it into two halves, which are perfectly similar as regards distribution of field; and, generally, this is true of all machines in which there is a double magnetic circuit There is here no tendency of the armature to move laterally in the field, provided its centre is concentric with the bore of the polar cavity. But with single-magnet machines it is different.

In fig. 4, for example—which is about the worst form of magnet, on account of the section being reduced at $b$ to half what it is at $a$—there is a strong upward magnetic pull, producing an abnormal pressure on the bearings, which may under some circumstances

lead to serious trouble from heating. Most makers of single-magnet machines have experienced some trouble from this cause, and have adopted, with more or less success, some means of curing the evil. A remarkable instance of the heating due to magnetic pressure on the bearings was recently brought to my notice by M. Heilmann, of the Société Alsacienne de Construction Mécaniques,

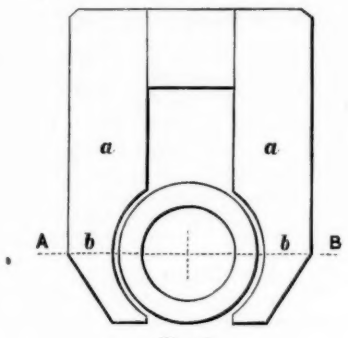


FIG. 4.

of Belfort. In the inverted machines first constructed by this company, the magnet cores, fig. 5, were of wrought iron, on the top of which were fitted cast iron pole pieces of comparatively small mass. From the look of the thing one would expect a very considerable downward pull, and in the case of some machines of 60,000-watt capacity the pressure on each bearing due to magnetic pull reached the high figure of 1,500 pounds. This, of course, led to serious heating, and in later machines the cylindrical wrought iron cores have been continued to the top of the

FIG. 5.

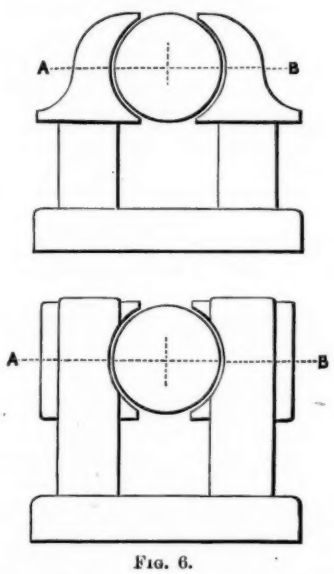


FIG. 6.

machine, as shown in fig. 6, being fitted with cast iron shells, which, together with the wrought iron limbs, form, when bored out, the polar cavity. It will be noticed that the reduction in the section of the wrought iron due to the boring out is very small, and I am informed that in this design the evil of heating has been completely abolished, a practically symmetrical field being produced. The machines are of the drum type.

In well-designed machines of the single magnet type there need be no trouble, however, from magnetic pull on the armature. The first essential is that the section at the thinnest part of the magnet be reduced as little as possible. The form in fig. 6, for example, where this is carefully attended to, may be cited as an example of good design; while that in fig. 4 illustrates a magnetically bad design. Since the induction always takes the path of least resistance, the importance of keeping up the full section of the limbs at the poles, in order that the resistance due to saturation may not cause unequal distribution of the field, will be obvious.

The magnetic pull may be balanced by the very simple device of placing the armature eccentrically in the field, as I suggested two years ago,* its centre being somewhat farther from the yoke than the centre of the polar cavity. In some cases the magnets, after boring out, have been brought closer, so that the air gap increases gradually to the polar tips; but though the pull is reduced to some extent by these means, the device is not so efficacious as the one previously mentioned. I understand that in order to reduce heating this latter course had to be adopted in the machines built for the Bradford Corporation, the magnets in these being somewhat similar in shape to that shown in fig. 4.

Electrically there is in drum armatures no want of balance due to an unsymmetrical field, as every convolution of the conductor encloses the whole of the lines of force passing through the armature core. The only result of a want of symmetry is that the position of the brushes on the commutator for a sparkless collection may become more marked, and the variation of current possible without readjustment of the brushes therefore less. But in cylinder-wound armatures not only is there a want of magnetic balance when the field is unsymmetrical, but from the fact that each convolution encloses only half the lines passing through the core, there is a want of *electrical* balance, and it becomes, in consequence, doubly important to get a symmetrical induction, or the same number of lines through each half of the armature. Though the lines were unequally divided there might not be any appreciable difference in the E.M.Fs. generated in each half with the brushes diametrically opposite; but from the fact that a want of electrical balance requires rather more lead to be given to the brush farther from the yoke, it is possible that the E.M.Fs. in the two halves of the windings may be unequal, the result being a local current round the armature, and consequent waste of power.

There are several methods of obtaining an approximately symmetrical field besides that already mentioned of placing the armature eccentrically in the cavity. What we have to do, if possible, is to make the path for the induction through the half of the cylinder core which is farther from the yoke, of similar resistance to the path through the nearer half, so that a similar number of lines may flow through each. In the Phœnix dynamo we employ sometimes, with this object in view, the device shown in fig. 7. Here the cast iron magnet, instead of being rectangular in section, has the inside corners cut away, as shown in the section

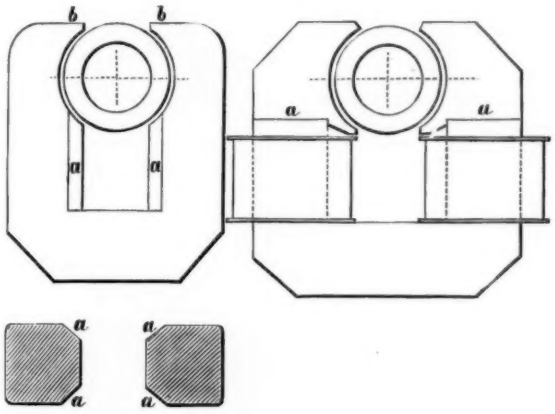


FIG. 7. FIG. 8.

at *a*, the top corners at *b* being left on. In this way the magnetic resistance across the bottom path is increased, and the induction in the two halves of the armature made equal. Another plan is to shape the magnets as in fig. 8, there being a faced joint at *a*. A plan adopted in several direct-driven ship sets we have just

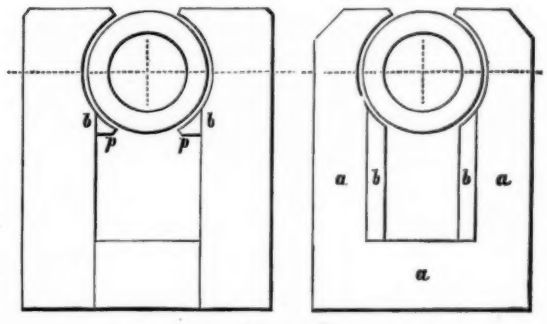


FIG. 9. FIG. 10.

completed is shown in fig. 9. The magnets are in this case of wrought iron, the limbs and top polar expansions being in one single forging, while the bottom polar expansions, *p*, are of cast iron. The magnetic resistance of the cast iron, combined with that of the joint at *b*, compensates for the diminished length of the

* The *Electrician*, vol. XX., page 114, 1887.

induction path through the lower half of the armature. Another design by which the same end may be attained is shown in fig. 10, where the magnet is partly of wrought iron, *a*, and of cast ron, *b*.

With a view to obtaining a more symmetrical field some single-magnet machines have been shaped as in fig. 11. Here,

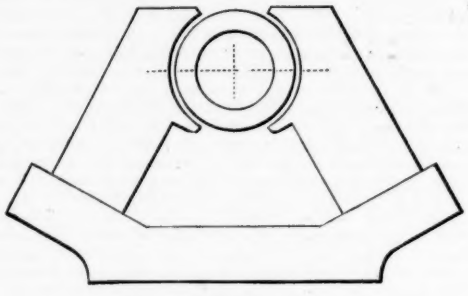

FIG. 11.

to attain the object, the magnetic circuit requires to be lengthened, the magnetising force required being correspondingly greater. In fig. 12 is sketched a single magnet machine in which the field is quite symmetrical, although here the magnetic circuit has been made still longer.

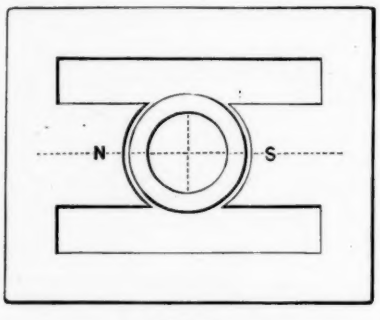


FIG. 12.

It will be understood that it is possible to have an armature out of balance magnetically while electrically it is perfectly balanced, as, for example, a drum armature in the mis-shapen

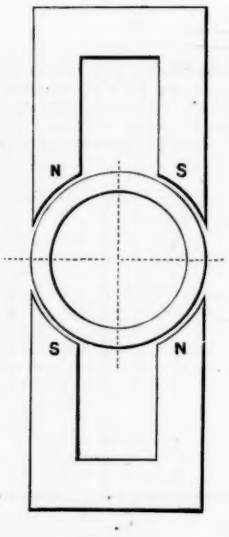


FIG. 13.

field, fig. 4. On the other hand, it is possible to have magnetic balance while electrically there is want of balance, as may be the case when a cylinder armature is placed in the four-pole field, fig. 13.

When the armature core is carried round by spider arms, which fit into slots in the iron washers, it is important that the reduction of the core area due to these slots be as small as possible. Variation in the section causes magnetic kicks, or periodic fluctuations in the field during rotation.

*(To be continued.)*

## NEW PATENTS—1890.

1784. "Improvements in and connected with the production of ozone by means of electricity." T. A. GARRETT. Dated February 3.

1822. "Improvements in electrically-actuated whistles, trumpets and horns, and in speaking tubes for domestic and business use, for hotels, for train intercommunication and other purposes." J. LEE. Dated February 3.

2056. "Means for holding telephone receivers." S. LEBENBERG. Dated February 7.

2080. "Improvements in devices for unloading, recharging and reloading electric car storage batteries." J. C. CHAMBERLAIN. Dated February 8. [Date applied for under Patents Act, 1883, sec. 103, 10th July, 1889, being date of application in United States.]

2091. "Improvements in secondary batteries and plates or elements therefor." W. P. THOMPSON. (Communicated by the Gibson Electric Company of Europe, France.) Dated February 8.

2108. "Improvements in or connected with switches for controlling electromotors." C. T. WHITMORE and W. H. AKESTER. Dated February 8.

2113. "Improvements in the manufacture of plates of electrodes as used in secondary batteries or accumulators." G. A. SCHOTH. Dated February 10.

2153. "Improvements in telephone switchboards." D. DEWAR. Dated February 10.

2172. "A new or improved mechanical switch for completing and breaking the circuit of electric tell-tales, for watchmen and the like, within a prescribed time." H. BOARDMAN. Dated February 11.

2199. "Improvements in cores and armatures for electromagnets and other purposes." S. C. C. CURRIE. Dated February 11. (*Complete.*)

2219. "Improvements in telegraph printing apparatus." H. O. RUDOLPH. Dated February 11.

2234. "Improvements in electro-mechanical movements, chiefly designed for regulating the carbons in electric arc lamps and for similar purposes." S. E. NUTTING. Dated February 11. (*Complete.*)

2255. "Improved multiple automatic transmission for telephonic and telegraphic systems." G. MACAULAY-CRUIKSHANK. (Communicated by M. Schwabacher, Germany.) Dated February 12. (*Complete.*)

2272. "Improvements in apparatus and devices for operating, compensating, regulating, measuring, and recording electric currents." A. C. COCKBURN and F. TEAGUE. Dated February 12.

2273. "Improvements in voltaic cells or primary batteries." G. R. POSTLETHWAITE. Dated February 12.

2298. "Improvements in and connected with electric calls and indicators for hotels." S. GARDINER. Dated February 12.

2302. "Improvements in electric batteries working with two liquids or electrolytes." H. WEYMERSCH and R. MCKENZIE. Dated February 12.

2337. "Improvements in electro-magnetic motors." G. R. POSTLETHWAITE." Dated February 13.

2439. "Improvements in or connected with electrical accumulators or storage batteries." F. S. ROBERTS. Dated February 14.

2464. "Improvements in electric light fittings." C. M. DORMAN and R. A. SMITH. Dated February 15. (*Complete.*)

2476. "Improvements in fusible cut-outs for electrical circuits." A. H. WALTON. Dated February 15.

2491. "Improvements in casings, beadings and mouldings, for containing, covering, and insulating electric wires for lighting or other purposes." W. GRITTEN and A. PARMLEY. Dated February 15.

2496. "An improvement in electrical conductors." J. B. KING and T. E. BICKLE. Dated February 15.

2503. "Improvements in electric arc lighting." L. SAUNDERSON. Dated February 15.

2504. "Improvements in apparatus for propelling vehicles by electricity, and for protecting electric conductors." F. WYNNE. Dated February 15.

2606. "Improvements relating to electric batteries." E. C. F. VERSCHAVE and A. BARON. Dated February 15.

## CORRESPONDENCE.

### The Electro-magnet.

In your leading article on this subject referring to Dr Silvanus Thompson's recent Cantor lectures, you say, "This unmitigated condemnation of the law of inverse squares seems to have surprised many of his hearers, among whom were not a few electrical engineers."

From this I gather that you consider that the law of inverse squares is totally incorrect as applied to the field of magnetism under any circumstances.

I venture to think, however, that the application of this law depends completely on the *form* of magnet.

In a horse-shoe magnet no doubt the magnetism in the field between the poles should vary directly as the distance, as here the air space between the north and south pole is in the direct magnetic circuit.

On the other hand, in the case of a long needle magnet, the magnetic influence must radiate almost equally in all directions, and, therefore, as the areas at different distances increase as the *squares* of these distances, the magnetic intensity at any point in these areas must show itself inversely as the *squares* of the distances.

Surely, therefore, in this case the law of inverse squares applies more truly than any other law.

A needle magnet is a form, however, which is almost entirely confined to the laboratory, and is hardly, in fact, made use of in practice.

The magnets used in dynamo-electric machines are of a form which involve complications owing to deflection and reflection of magnetic influence, and the determination of the intensities of magnetism at different distances of poles must of necessity be exceedingly complex. There is no reason why these intensities of magnetism should not, however, be determined.

It is well known that with light, in certain cases, the intensity varies inversely as the square of the distance; in other cases, where reflectors or lenses are introduced, the intensities vary inversely as the distances—as, indeed, is instanced in the practice of lighthouse illumination.

It is also well known that by lenses it is possible to focus light in such a manner that the greater the distance the more intense the light in a given area.

I maintain that all these effects can be reproduced in the magnetic field, and it is only a question of finding out the most convenient and efficient manner of doing so.

It is possible that when you read the foregoing you will be ready to admit that after all the wholesale condemnation of the law of inverse squares is hardly justified under all circumstances.

**Charles Bright,**
*Assoc. M. Inst. C.E.*

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### Recalescence.

At the meeting of the "Institute of Electrical Engineers," on the 9th of January last, Sir William Thomson, after reviewing some of the facts and theories advanced by Dr. J. Hopkinson, in the course of his inaugural address as President of the Institution, on the subject of "Magnetism," referred to the immense importance of the recalescence phenomenon, suggesting the need of further investigation at temperatures a little above and a little below the critical one, and remarked: "If the effect described is reversible, then the material should cool while heat is being supplied to it."

Something less than a year ago a somewhat brief experimental investigation of the subject was made by Prof. Elihu Thomson; and, I believe, the results obtained he embodied in a brief paper which appeared in the columns of your journal. Some new phenomena were then observed which meet, to a considerable extent, the suggestions of Sir William Thomson. I will state my recollections of the subject.

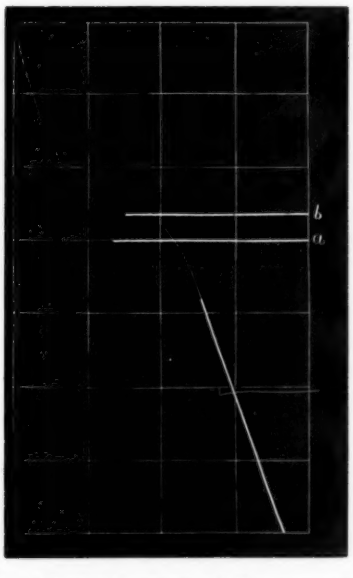
While engaged in the early development of his now well-known electrical method of welding metals, the attention of Prof. Thomson was strongly arrested by the magnitude of the recalescence phenomenon. It was then frequently pointed out by him, and the investigation above referred to was subsequently undertaken with the view of determining, if possible, the changes undergone by the material at temperatures around the critical one at which the effect showed itself. Stated quite briefly, the results of the investigation were as follows:—

1. The temperature of decalescence, and the quantity of heat rendered latent during the heating of the material, was found within the range of observation to bear a certain relation to its hardness, presumably, to the percentage of combined carbon contained in it. The hardest specimen of steel observed possessed the highest critical temperature, and recalesced with most vigour. When softer specimens of steel were tested under like conditions, the waves of recalescence were less marked, and occurred at lower temperatures. With soft iron bars the effect was not observed.

2. The temperature of decalescence, the critical temperature at which the material *cooled* while heat was being supplied to it was higher than the temperature of recalescence during during cooling.

3. Heating the material from a point a little below to one a little above the critical temperature, and vibrating the temperature thus many times in succession, seemed to induce in the material a condition of exhaustion. At any rate the magnitude of the phenomenon was lessened by such treatment, allowing the material to cool off, or raising the temperature to a point considerably above the critical one, restored to the material the power of vigorous recalescence.

4. With the object of locating the point in the curve at which the resumption of magnetic qualities took place, a hard steel bar was submitted to observation. Let that part of the temperature curve, included between the horizontal lines, *a* and *b*, (see fig.) represent the sudden rise of temperature due to the liberation of




latent heat. After the crest of the wave was passed, and just as the temperature curve passed the level, *a*, the restoration of the magnetic capacity of the bar was commenced.

It would be exceedingly interesting in this relation to ascertain, by measurements closer than were possible with the apparatus constructed by Prof. Thomson, whether or not it is possible that the same piece of steel, at the same temperature—before and after recalescence—can exist in two different states, as regards its capacity for magnetisation?

**Robert Shand.**

Lynn, Mass.

### Tests of Westinghouse Converters.

Referring to an article on "Tests of Westinghouse Converters," in your issue of January 31st, 1889, I beg leave to call your attention to a letter from myself in the *Electrical World* for February 1st. The publication of Mr. Marshall gives figures which are solely the work of students, and was made wholly without my knowledge or consent. If you will make this fact public through your journal you will greatly oblige

**Chas. R. Cross.**

Boston.

[We have already set this matter straight in a note entitled "Breach of Confidence," in our issue for February 14th.—EDS. ELEC. REV.]

### Electricity and Wine.

As I have noticed various paragraphs in the ELECTRICAL REVIEW with regard to the above, I think it will be of interest to give an extract from Mrs. Crosse's memoirs of her husband, the late Andrew Crosse, of Broomfield, near Taunton, who was a member of the old Electrical Society. The book was published in 1857. Mrs. Crosse writes :—

"Mr. Crosse directed his attention to the purification of sea water and other fluids by electricity. The application of this principle to wines and brandies has been attended with great success. It has the effect of softening the asperities of some wines by removing the predominance of bitartrate of potash ; and in the case of the spirit distilled in imitation of French brandy, the improvement to be derived from the process is remarkable. In one experiment two gallons of the very worst English brandy were kept electrified for three weeks ; at the end of that time the spirit was drawn off infinitely improved—indeed, *visibly* purified. This process has also been applied most effectually to stopping the *fermentation* in cider. The antiseptic properties of electrified water is very remarkable. Pieces of meat and the skins of animals in a state of putridity have been immersed in electrified water, and in a few hours rendered inodorous."

**F. T. J. Haynes.**

Taunton, *February 22nd*, 1890.

### Arc Light Globes.

I am glad to see that some are beginning to use the arc light without an obscured globe. There cannot be a greater folly than after you have got a good light to go and dim it. After all it is nothing compared with pure light. At the best, that is without an obscured glass hole, it is only equal to moon light, which, curiously, it so closely resembles that I doubt if anyone could distinguish an object illuminated by it from one by the moon, if he did not see the source of the light. The beauty of the star light radiation from an arc light seen through a clear glass lamp, as displayed at some of the theatre doors and on other buildings, cannot be surpassed. The portico of the British Museum would look magnificent lighted in this way, and the same with St. Paul's. In interiors it would be equally fine, and if the lights were kept high, then there need be no inconvenience from dazzling the eyes, as there is no necessity to fix your eyes on the ceilings of high rooms.

I wonder if it has been tried for moon light effects on the stage. Its great defect, as an interior light, is that it is too much like moonlight, that is, too cold. It will be a good thing when the patents for incandescent lamps, not one of which, according to Judge Hawkins, is valid, expire, and we get rid of the monopoly and imposture. But in the mean time there is no sense in paying for arc light and then reducing it in quantity and not improving it in quality with obscured globes. Could not some chemical substance, such as soda, be burned along with the carbon to produce a warmer light for interiors ?

**H. W. Fawcus.**

*February 23rd*, 1890.

### Theory of the Leyden Jar.

I sent Dr. Lodge a copy of the first part of my book, entitled "The Etheric Theory of 1839 is the True Theory of the Leyden Jar." Having received from him a letter which I saw might do good, if published, in that it would give editors and others freedom to write without bias on the subject, I requested Dr. Lodge's permission to publish it, and as he has consented I send you a copy.

**James Johnstone.**

[Copy.]

21, Waverley Road, Liverpool,
*15th February*, 1890.

To James Johnstone, Esq.

Dear Sir,—I am indebted to you for a pamphlet, in which you subject my little book, "Modern Views," to a criticism which cannot but be wholesome.

It depends on what is meant by "electricity passing through glass." In a sense it certainly does, but not by conduction. I expect you have got hold of a true idea in connection with the matter.

Yours truly,
(Signed) OLIVER J. LODGE.

### Far-Distance Dynamo.

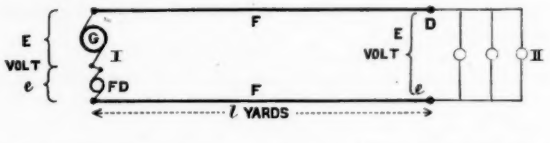
We notice by your leader of February 21st you say that for long distances, high-tension currents must of necessity be employed if commercial success be aimed at.

We beg to inform you we are constructing a special far-distance dynamo, by which the E.M.F. of the substations is exactly the same as the main dynamo terminals.

Its application is to add a certain E.M.F. to the constant E.M.F. of the main compound dynamo, which must be equal to the loss of potential in both the feeders, as shown by sketch hereafter.

The F.D. is always placed in series with the compound dynamo, G, and the feeders, F, F, shown above.

In this case the F.D. adds its E.M.F. directly to the constant E.M.F. or the dynamo, G. In order that the lamps at the far-distance may burn always with the same brightness, the potential between D and $e$ must be constant. This will be the case if under all circumstances (whether the number of lamps be altered or not) the E.M.F. of the F.D. is equal to the loss of potential in the feeders, F, F.




For example, suppose "I" be the machine room with "II" the far-distance, the lamps are placed, say, one yard apart. These lamps at a maximum require a current of "C" ampères, and a constant potential of "E" volts. The highest loss of potential in the feeders be "$e$" volts. The resistance "R" of the feeders will then be $R = \frac{e}{C}$ ohm, and the copper section, Q, of the feeders, therefore, must be :

$$Q = \frac{1}{33{,}600} - \frac{2\,l\,C}{e} \text{ square inch.}$$

For "$e$" we have the equation : $e = C\,R$ volts.

The F.D. in this general case must be constructed so as to give "$e$" C volt-ampères, namely, "$e$" volts with "C" ampères. As the dependence of "$e$" and "C" in our F.D. is given through a straight line, the E.M.F. of the F.D. is always proportional to the current "C," viz., to the number of lamps. The loss of potential in the feeders will, therefore, under all circumstances be equalised by the F.D., and the potential of the lamps will be constant, and also their brightness.

**Bolling & Lowe.**

*February 24th*, 1890.